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ABSTRACT

The development and accomplishments of the National Aeronautics and Space Administration (NASA) from its inception in 1958 to the final preparations for the Apollo 11 mission in 1969 are traced in this brochure. A brief account of the successes of projects Mercury, Gemini, and Apollo is presented and many color photographs and drawings of the astronauts, spacecraft, and the vast complex of facilities of NASA's Manned Spacecraft Center are included. Also included are pictures photographed in space from the various spacecraft. Cutaway drawings of spacecraft and launch vehicles are used to illustrate the complexity of these vehicles. The booklet concludes by mentioning some of the plans for future space exploration into the 1980's. (FL)

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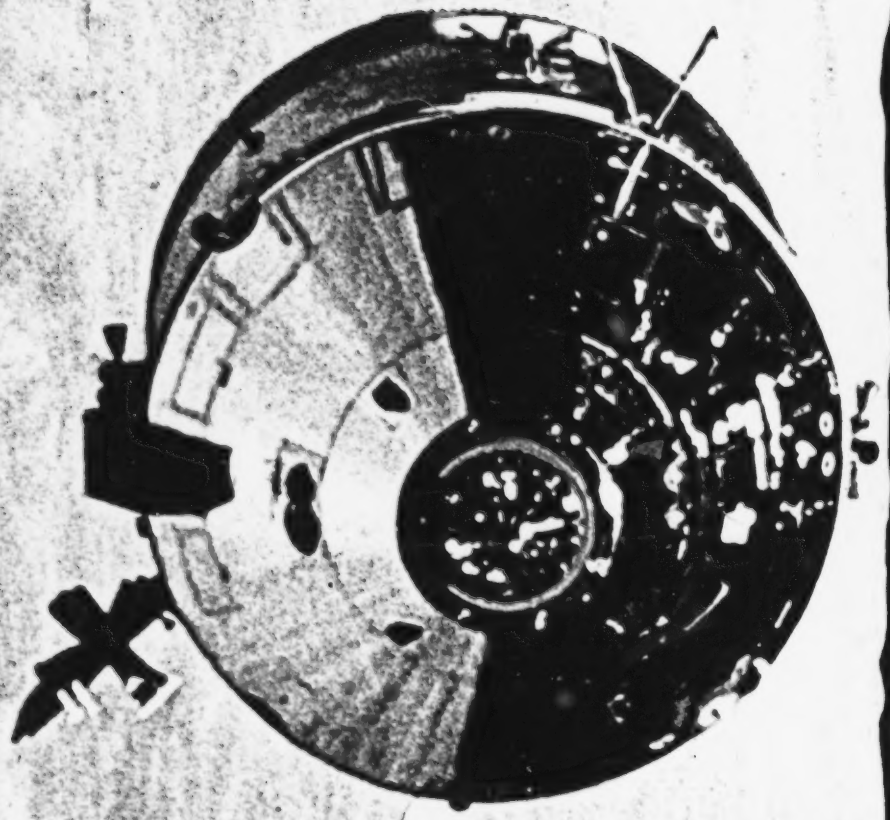

"IN THIS DECADE..."

Mission To The Moon

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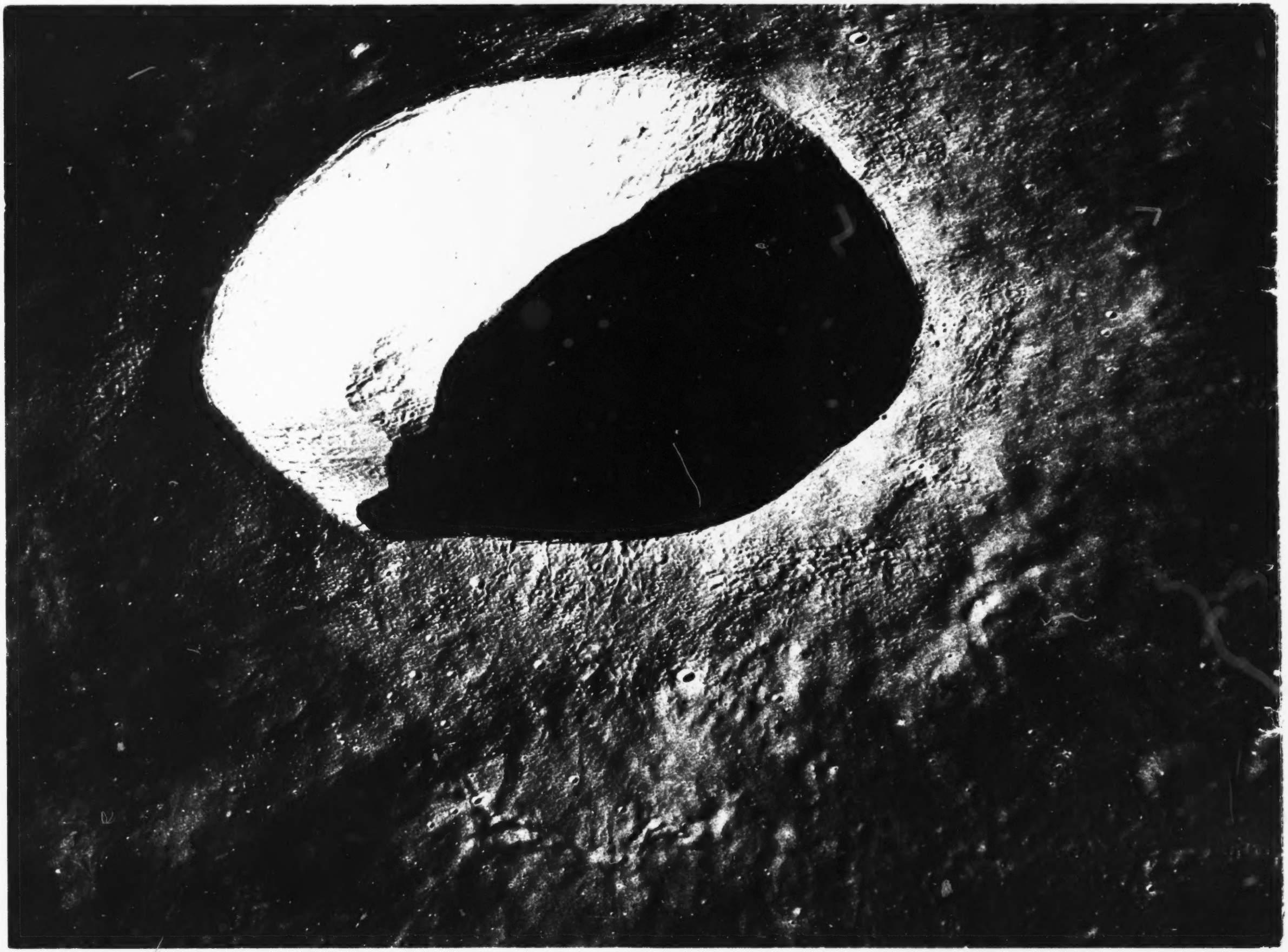

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"IN THIS DECADE..."

Mission To The Moon

While the Moon has been the focus of our efforts, the true goal is far more than being first to land men on the Moon, as though it were a celestial Mount Everest to be climbed. The real goal is to develop and demonstrate the capability for interplanetary travel. With some awe we contemplate the fact that men can now walk on extraterrestrial shores. We are providing the most exciting possible answer to the age-old question of whether life, as we know it on Earth, can exist on the Moon and the planets. The answer is yes. Men working together with modern science and technology can extend the domain of terrestrial life throughout the solar system.

Thomas O. Paine
Administrator
National Aeronautics and Space Administration

1

AN END—AND A BEGINNING

Today and tomorrow and the day after tomorrow . . . these now are the measures of time until man's greatest adventure.

For decades, men have dreamed of reaching the Moon, and of using it as a springboard to the stars. For years, it has been a goal. And now, it is only a matter of days and hours until the silent cold welcomes Moon's first visitors.

First one, and then a second, American astronaut will descend from their landed spacecraft to stand alone on the surface of the Moon. But in the larger sense, they will not stand there alone; hundreds of thousands of other men and women will have put them there with their dreams, ideas and hard work.

For Project Apollo is a focal point of a national decision, voiced by President John F. Kennedy in 1961, that ". . . this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to Earth."

Then, 1970 seemed so close, and the task loomed so large, that many believed such a timetable could not be met. The management and coordination of that formidable assignment were given to the National Aeronautics and Space Administration, a three-year-old fledgling organization.

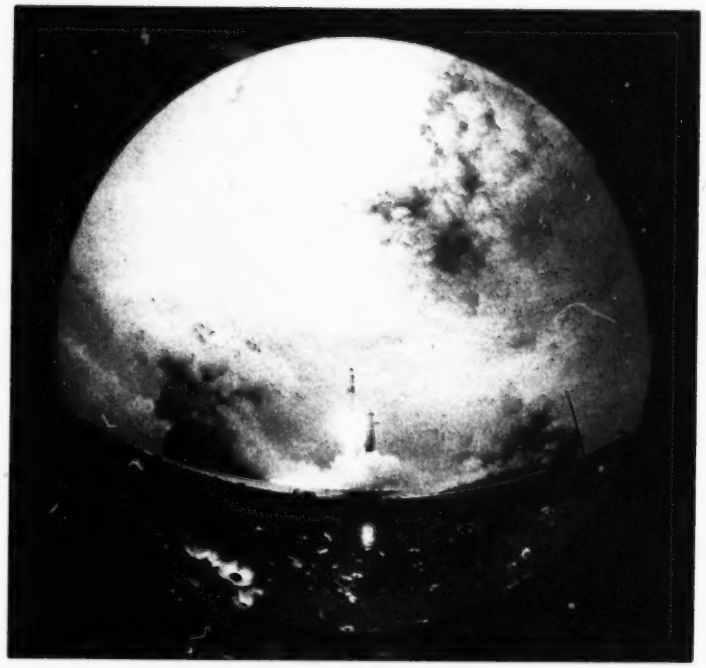
The NASA nucleus was a handful of researchers in the problems of space flight. Over the years they grew in number, to be joined by others in universities, industry and government, and to work in a huge team eventually numbering in the hundreds of thousands. Together, they have built a powerful capability, a national resource, based on a whole new technology of manned space flight and including the surrounding complexes of communication systems, test stands, assembly buildings and launch sites.

The astronauts who first set foot on the lunar surface will stand at an end and a beginning—the end goal of the specific Apollo 11 mission, and the beginning of man's exploration of the world beyond his Earth. They will stand alone, but hundreds of millions of people will share those minutes with them through television and radio. The awesome feeling of that first contact with a new world will touch the minds of people who speak every tongue, wear every dress, inhabit every region of Earth.

And so the lunar landing—that first step towards the stars—will represent more than a triumph of technology over time and distance. It will be a single moving experience to be shared in a brief bond of worldwide brotherhood.

Then it is not important who is standing there. What is important is that man is standing there.

"In throwing wide the horizons of space, we have discovered new horizons on Earth." President Nixon in Inaugural Address, 1969.



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OF AIR AND SPACE

Since its inception in 1958, NASA's programs have explored the broadest range of problem areas in aeronautics and space.

Before Apollo, NASA successfully completed two other manned space flight programs, Mercury and Gemini, launched more than 150 scientific satellites into space, and fired thousands of rocket probes into the upper atmosphere. Observatory spacecraft, unhampered by the Earth's obscuring atmosphere have probed, photographed and measured the distant reaches of space. They trained their instruments on the stars and closely examined our Sun and have gathered useful information about the Earth and its environment.

America has cooperated with other countries in scientific programs in the exploration of space. Great Britain, Canada, Italy and France have designed and built scientific satellites carried into space by United States launch vehicles. Other European countries are planning experiments or spacecraft for future flights.

Worldwide relays of live television coverage of news events have been made possible by communications satellites, pioneered in NASA experiments. Global weather patterns now are seen from weather satellites that send their observations to Earth stations for faster, more accurate forecasting. Earth's natural resources—its forests and watersheds—can be surveyed from space. This holds great promise for the future. Navigation techniques have been improved through the use of instruments and concepts utilized in satellites.

NASA's involvement with aeronautics has run long and deep. One recent major research program was devoted to the development of an economically feasible design for a supersonic transport.

In other aeronautical research programs, the flight boundaries of manned aircraft were extended into new speed and altitude ranges by the X-15 and XB-70 research aircraft. Lifting bodies, whose carefully contoured fuselages substitute their lift for missing wings, probe the potential of re-usable spacecraft. A generation of vertical- and short-takeoff-and-landing (VTOL and STOL) aircraft have been flown by NASA pilots in flight research programs to solve some problems of short-range transportation.

NASA's work in space exploration and aeronautics is requiring advances in practically all fields of science and technology, and many of these advances are proving useful also in non-aerospace industries and in medicine. Such knowledge is made available to potential users through publications and data banks that can be quickly searched by computer for answers to specific questions.

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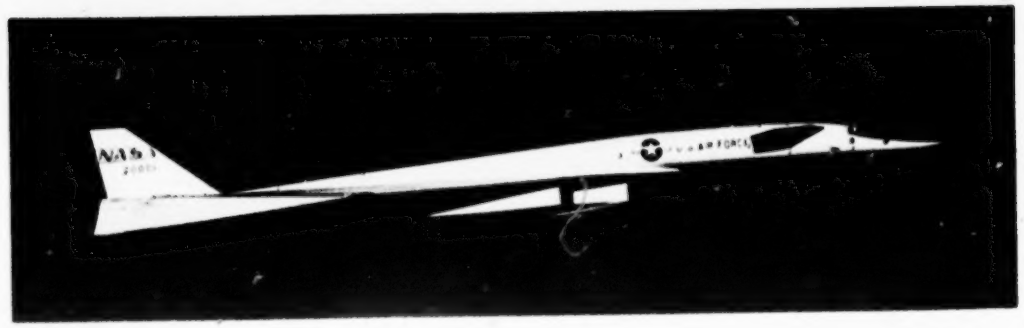

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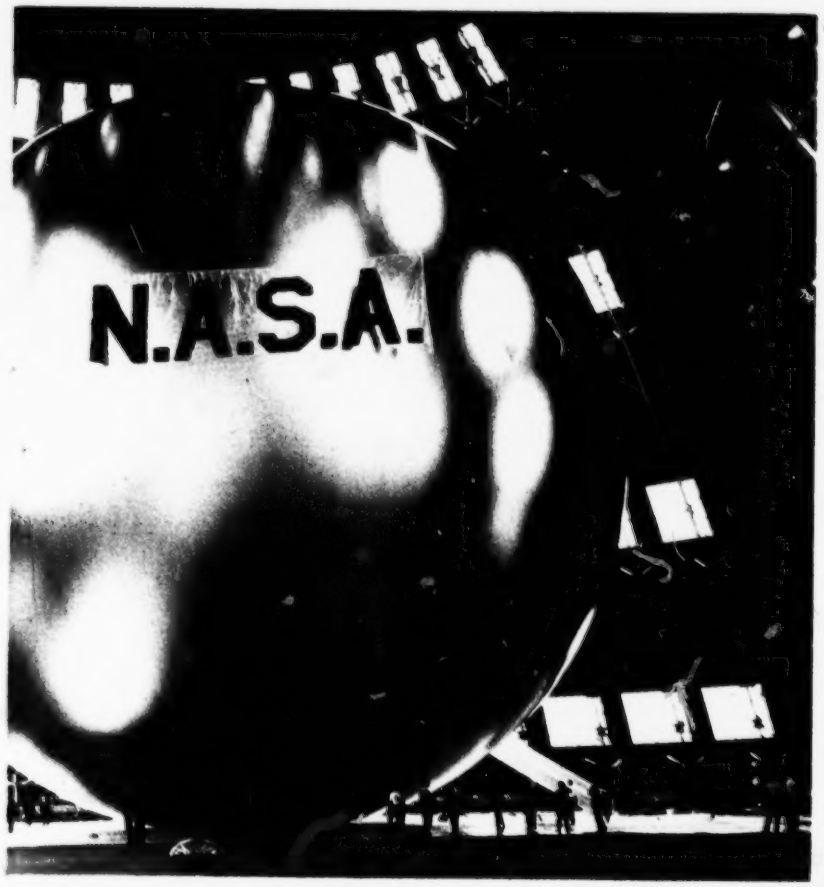

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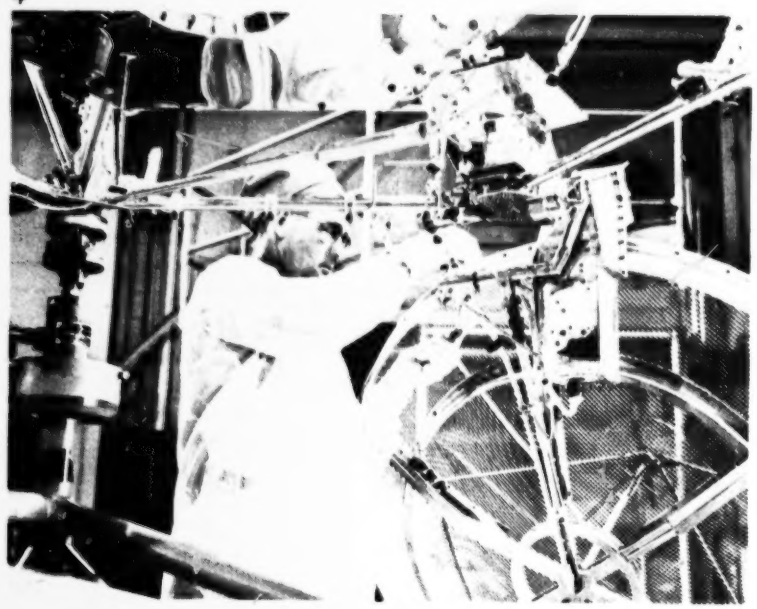

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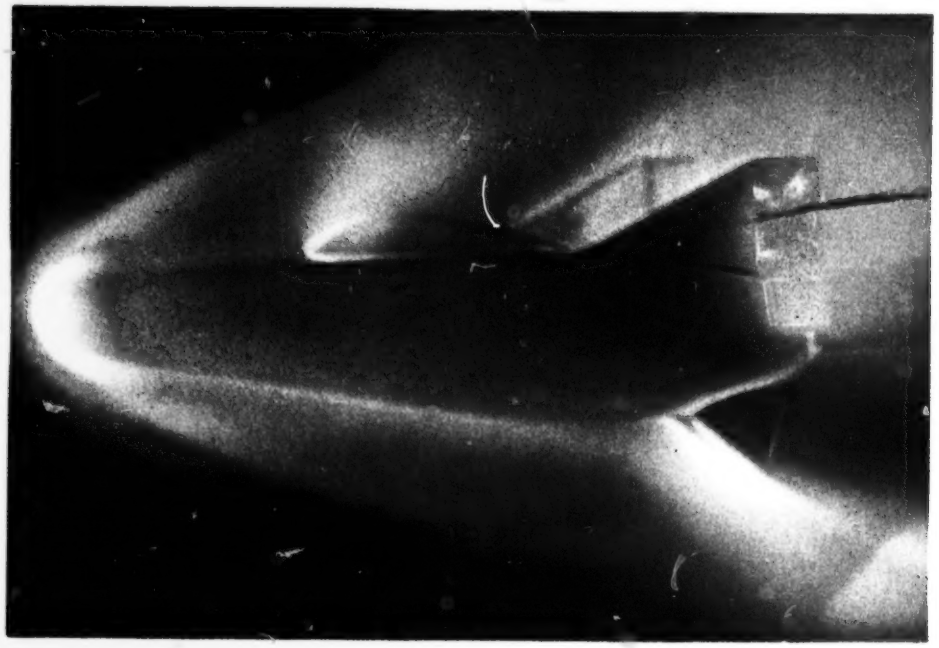


1. An Applications Technology Satellite color photograph of the Earth from 22,300 miles in space.

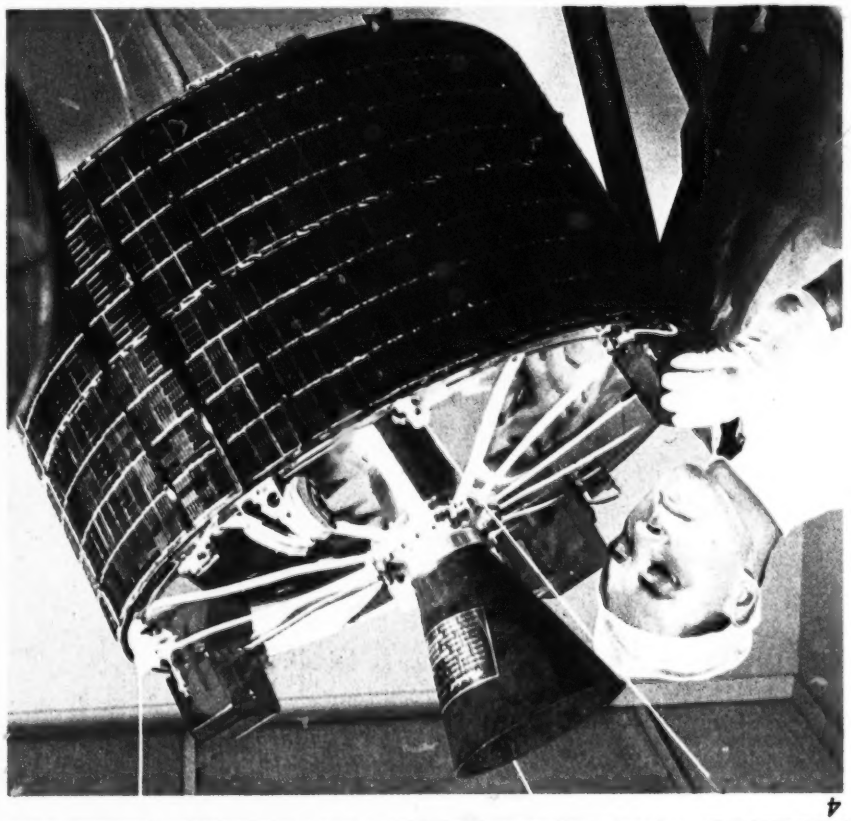
2. The XB-70 furnished flight data for the supersonic transport program.

3. An inflation test of the Echo II passive communications satellite.

4. A technician works on the high-gain antenna arm of the Venus-bound Mariner II spacecraft.

5. Advanced electric propulsion systems are tested in this vacuum chamber.

6. A wingless Lifting Body model undergoing high air velocity wind-tunnel tests.



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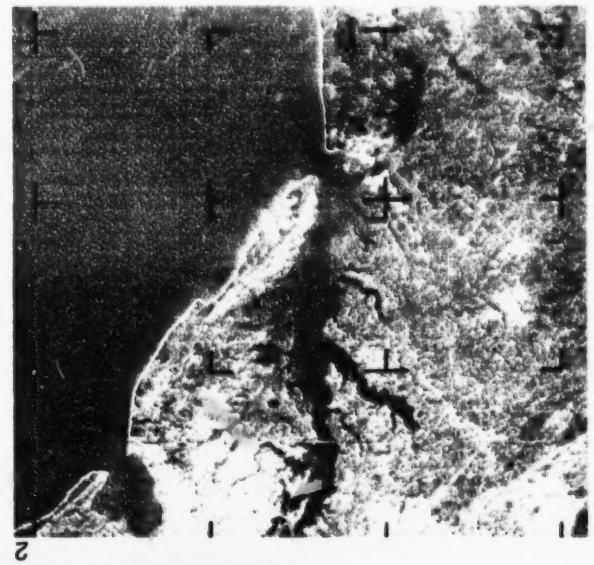

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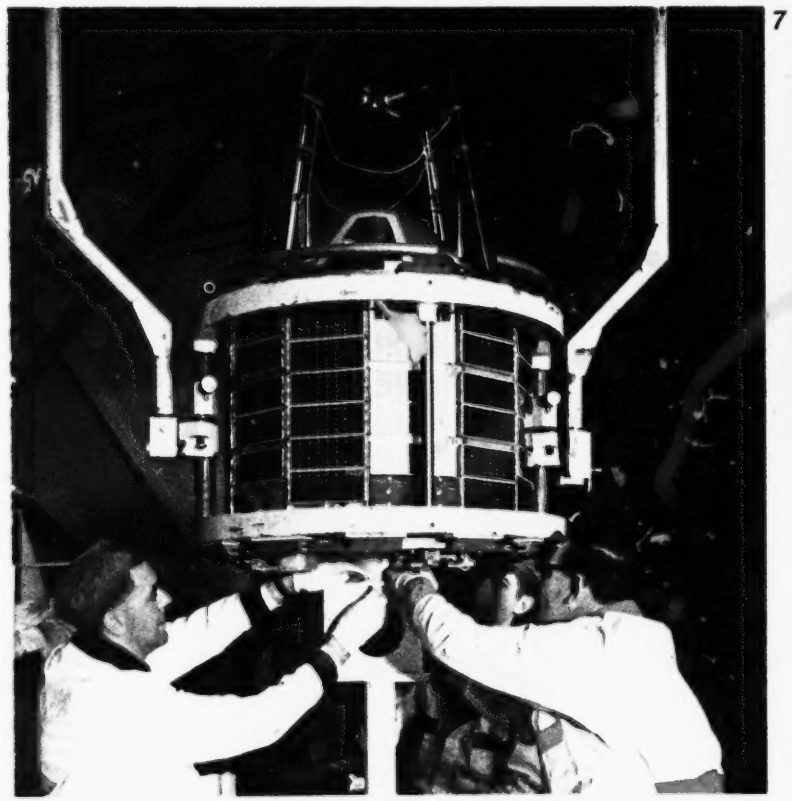

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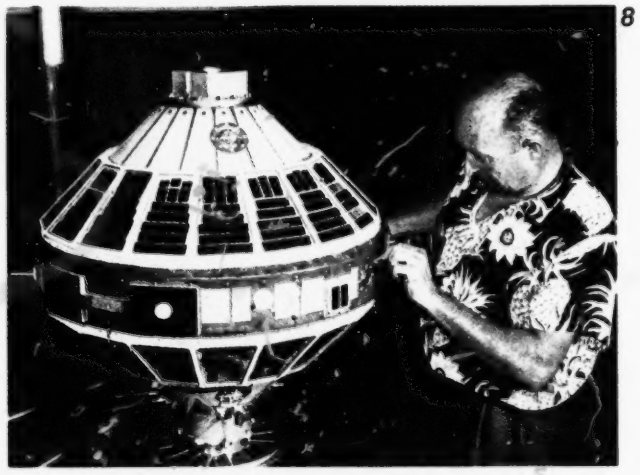

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1. All the world's weather shown in a single photomosaic made from 450 exposures taken by TIROS IX.

2. A Nimbus I weather satellite photograph of the Washington, D. C. area.

3. A Mariner IV digital representation of the surface of Mars.

4. Assembling a SYNCOM communications satellite.

5. Auxiliary tanks on the X-15 research aircraft increased fuel capacity for higher performance.

6. Technician checks out an Orion II sounding rocket, prior to launch.

7. The final inspection of a United Kingdom satellite before mating to its launch vehicle.

8. Adjusting complex circuitry in the Explorer VII.

"Space will be explored for many reasons—scientific, economic, military, political. The question is not why, but when, and by whom?"—Dr. Hugh L. Dryden, 1960.

3

BLAZING THE TRAIL

The first American in space, Astronaut Alan B. Shepard, Jr., rode his one-man Mercury spacecraft in a sub-orbital flight that lasted just over 15 minutes. That was little more than eight years ago.

Today, three astronauts are poised for the Apollo 11 mission which will land two of them on the Moon's surface. Their spacecraft contains their life support systems, and a host of specialized instruments and equipment items that make the long flight possible.

Project Mercury was the first step in the planned program of manned space flight. Its aims were simple: Put astronauts in space, learn about their abilities to function in the new environment and recover them safely.

The memorable Earth-orbiting flight made by Astronaut John H. Glenn, Jr. was a landmark in manned space flight.

The Mercury program concluded with a 34-hour space flight by Astronaut Gordon Cooper to meet the final program objective of spending one full day in space. The two sub-orbital and four orbital flights of Project Mercury were a major step in America's manned space program.

The two-man crews of Project Gemini, America's next manned space flight program, were to extend the experiences and capabilities of man in space, and to solve some of the problems anticipated in the Apollo flights.

The first of the ten manned Gemini flights checked the two-man spacecraft and its systems in three orbits of the Earth; the second unrolled 62 revolutions of the Earth in a long-duration flight that saw the first "walk" in space.

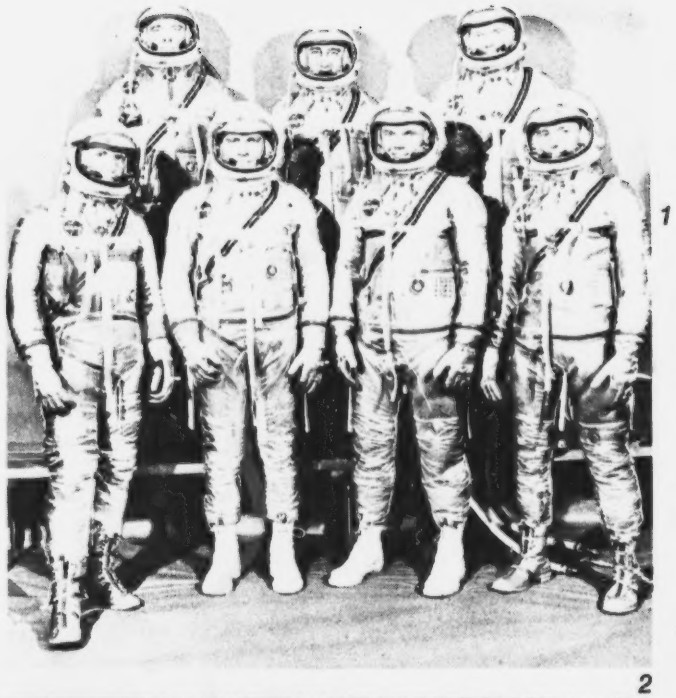
Gemini flights passed new milestones: The first space rendezvous, space flight duration records, the first docking of two vehicles in space. An astronaut "walked" from one vehicle in space to another, and walked back.

The Gemini program ended with a 59-revolution flight, including more than 5½ hours of walking and working outside.

Project Gemini pioneered the technique of the space rendezvous, the critical maneuvering and meeting of two spacecraft which is essential to the Apollo flights.

More, it provided experience in long-duration space flights, developed new ground-crew skills, and tested re-entry and recovery methods.

Perhaps most importantly, Gemini provided the nucleus of the highly trained and experienced flight crews that would man the Apollo spacecraft.



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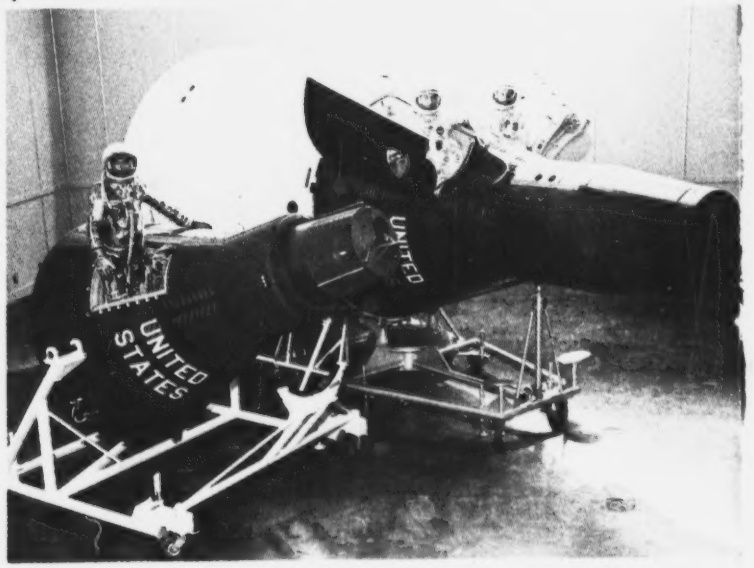

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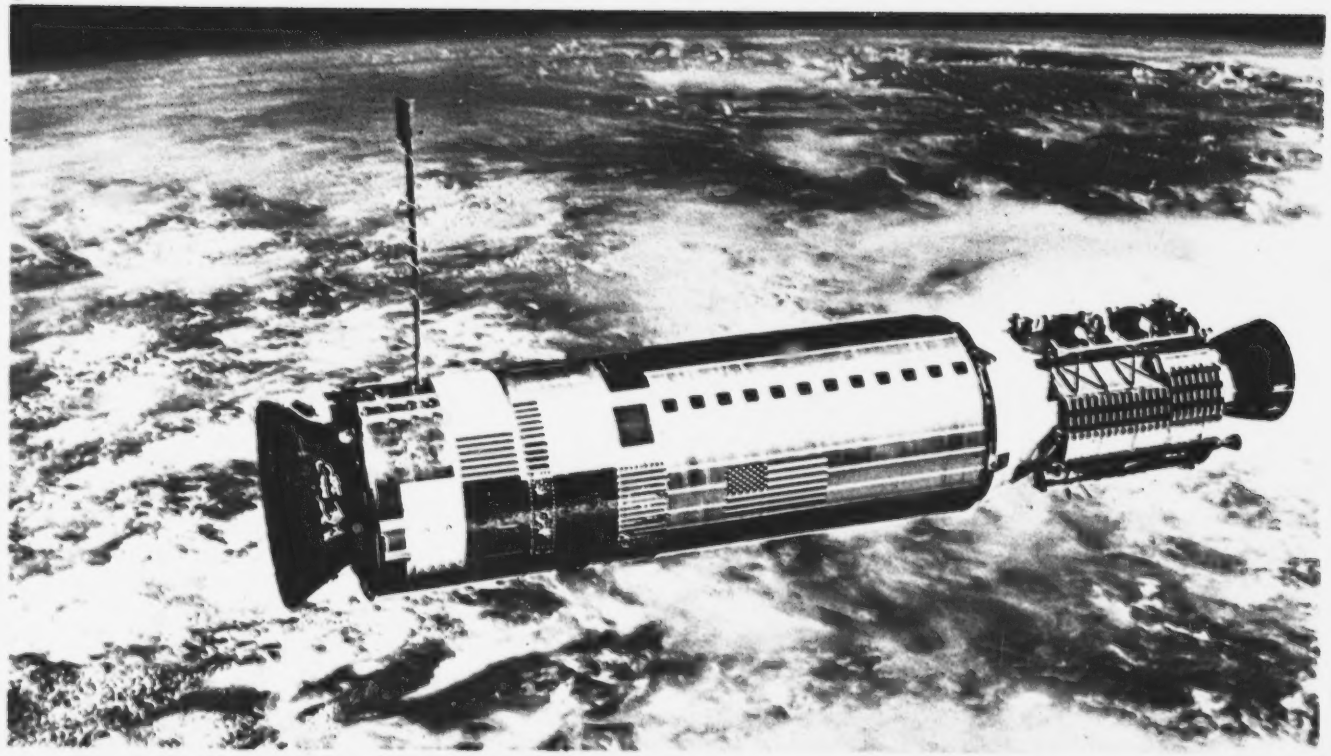

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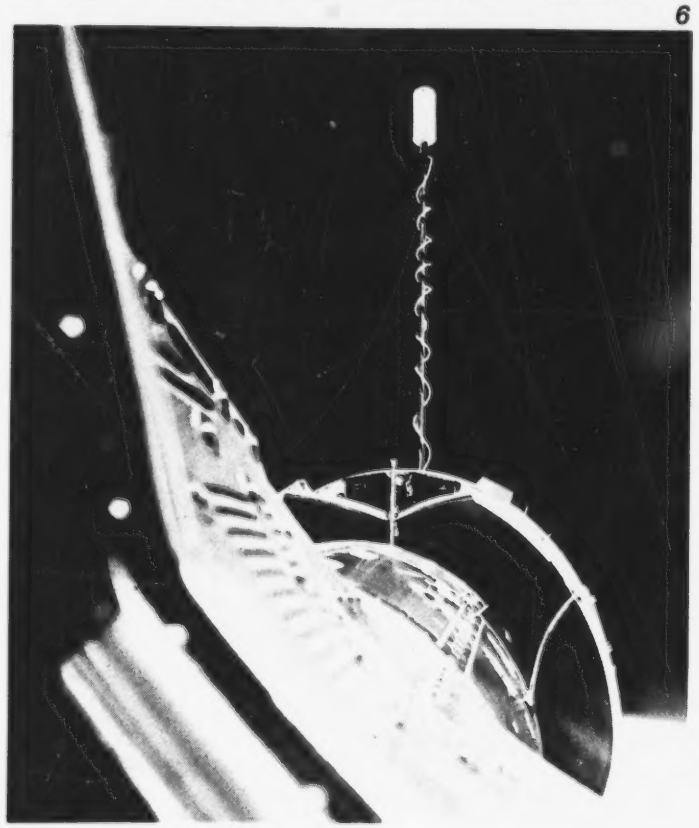

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1. Project Mercury astronauts were Schirra, Slayton, Glenn, and Carpenter (front row); Shepard, Grissom, and Cooper (rear row).

2. Astronaut Shepard, first American in space, is recovered by helicopter after suborbital flight.

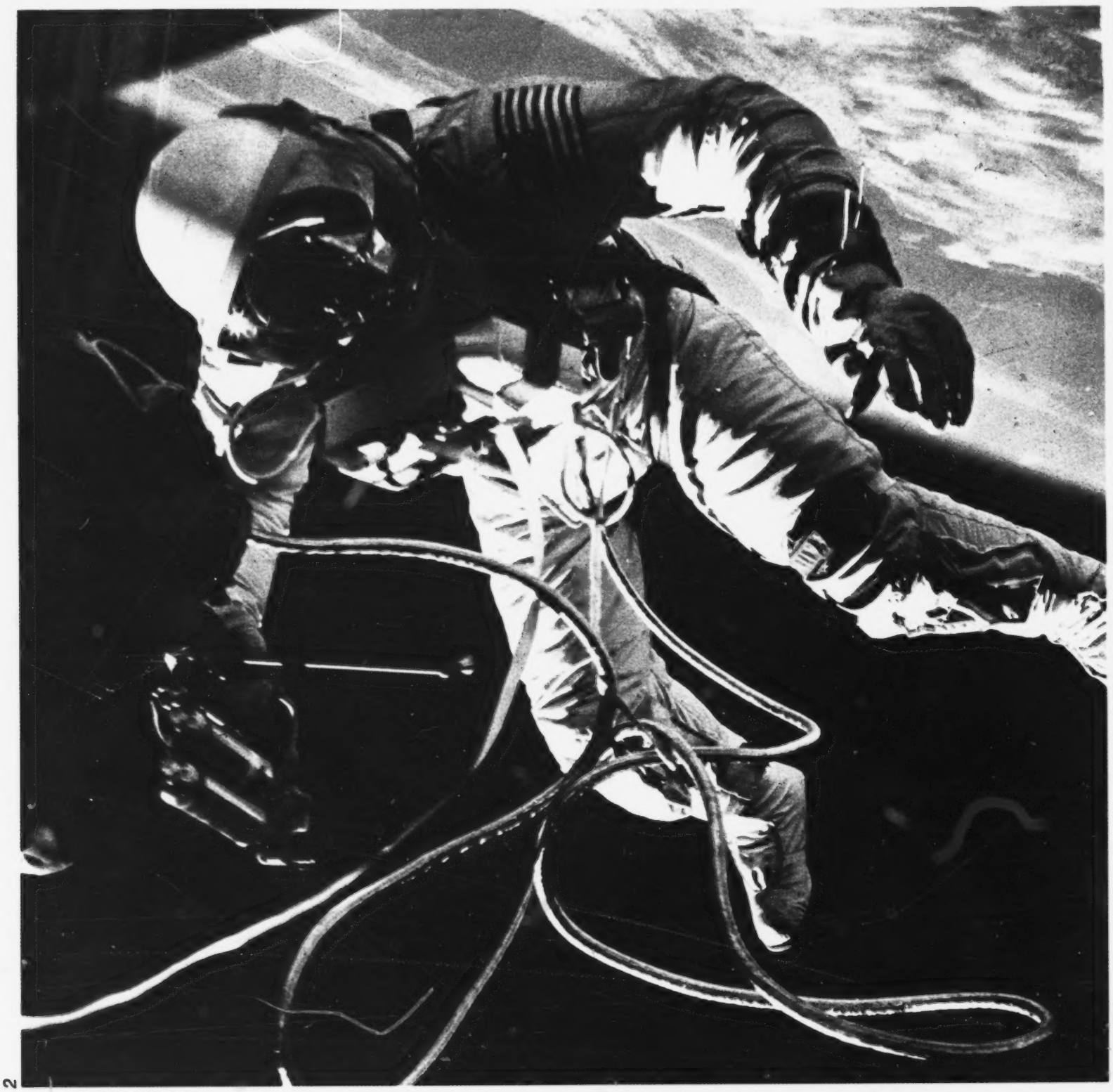
3. John Glenn boards the Friendship 7 spacecraft for the first U. S. Earth orbital flight.

4. Mercury (left) and Gemini (right) show comparative size of one- and two-manned spacecraft.

5. Gemini XII astronauts Lovell and Aldrin photographed this Agena target vehicle from 55 feet away.

6. Astronaut Young had this view of the docking of Gemini X with an Agena target vehicle.

7. A Gemini IV view of the Nile Delta and Egypt; with the Mediterranean Sea to the left and the Suez Canal and the Red Sea in the background.



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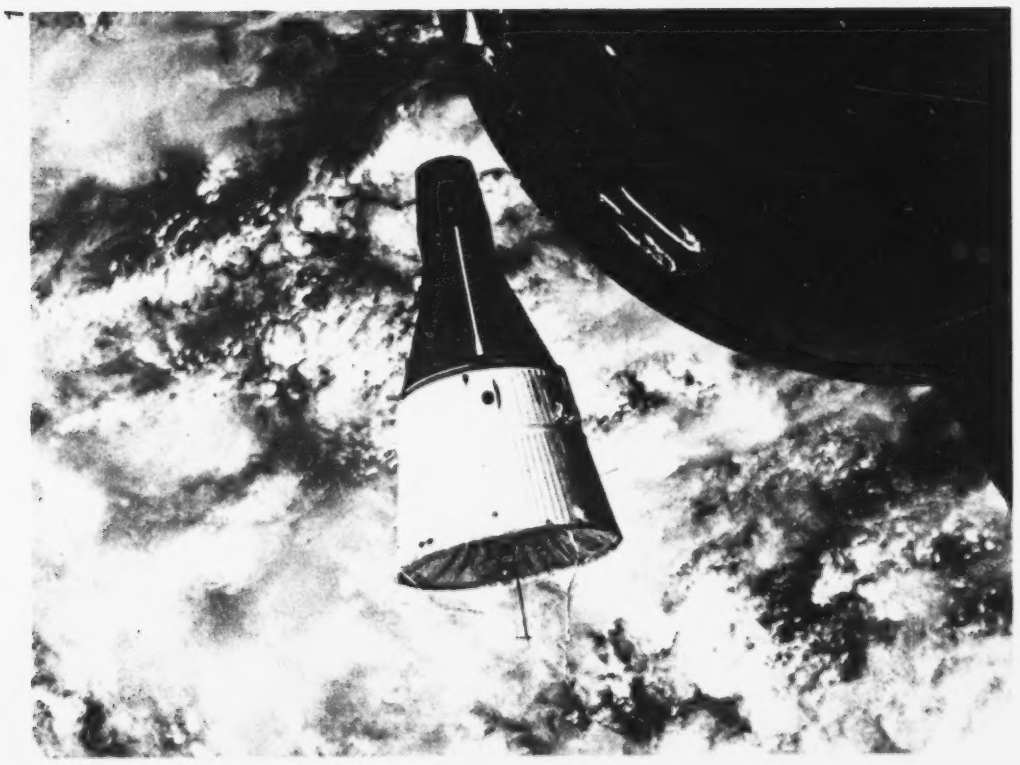

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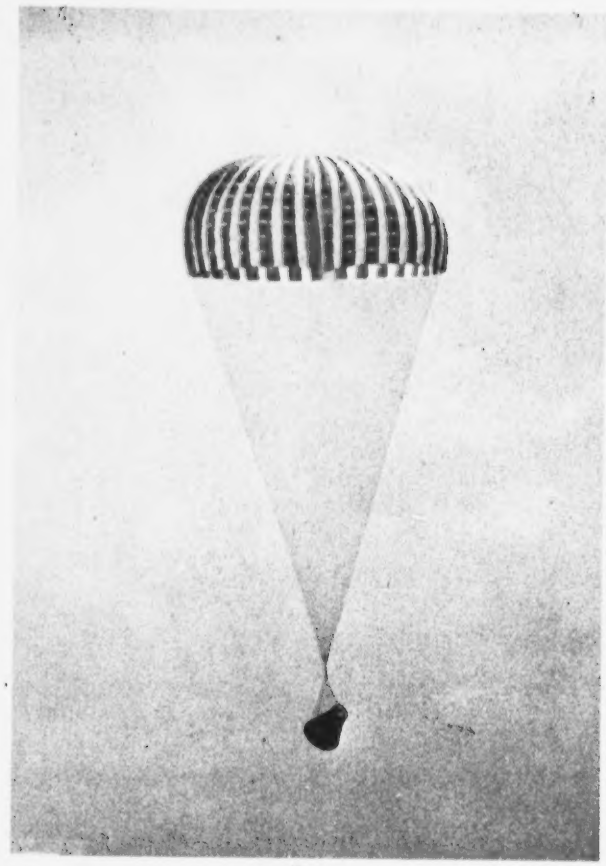

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1. Two Gemini spacecraft, Gemini VI and Gemini VII, perform station keeping maneuvers after rendezvous, while orbiting 160 miles above the Earth.

2. Gemini IV Astronaut Ed White, the first American to perform Extra Vehicular Activity (EVA), floats alongside his orbiting spacecraft.

3. The descent of Gemini XI prior to splashdown in the Atlantic Ocean.

4. Frogmen leap to aid in the recovery of a Gemini spacecraft.

5. Gemini IX Astronauts Cernan and Stafford await helicopter recovery after their mission.

5

4

AND NOW APOLLO

Mercury and Gemini were tied to the Earth. For Apollo, Earth-orbiting would just be a starting point. The flights would break the bond of Earth and head out into space, eventually to orbit and land on the Moon.

Now, the manned exploration of space seemed ready to pass from the realm of science fiction into the world of of reality.

That exploration would start logically with the Moon. New scientific information about the Moon, and possibly about the Earth itself, would be one result. Lunar orbiting, rendezvous and landing could also serve as rehearsals for later interplanetary exploration.

To do this job would require the development of new spacecraft and new launch vehicles. It would also demand the design and construction of a vast complex of ground facilities needed to build, test and assemble these spacecraft and launch vehicles. It would require an enormous electronic network to watch and observe the spacecraft on their long voyage to the Moon and back.

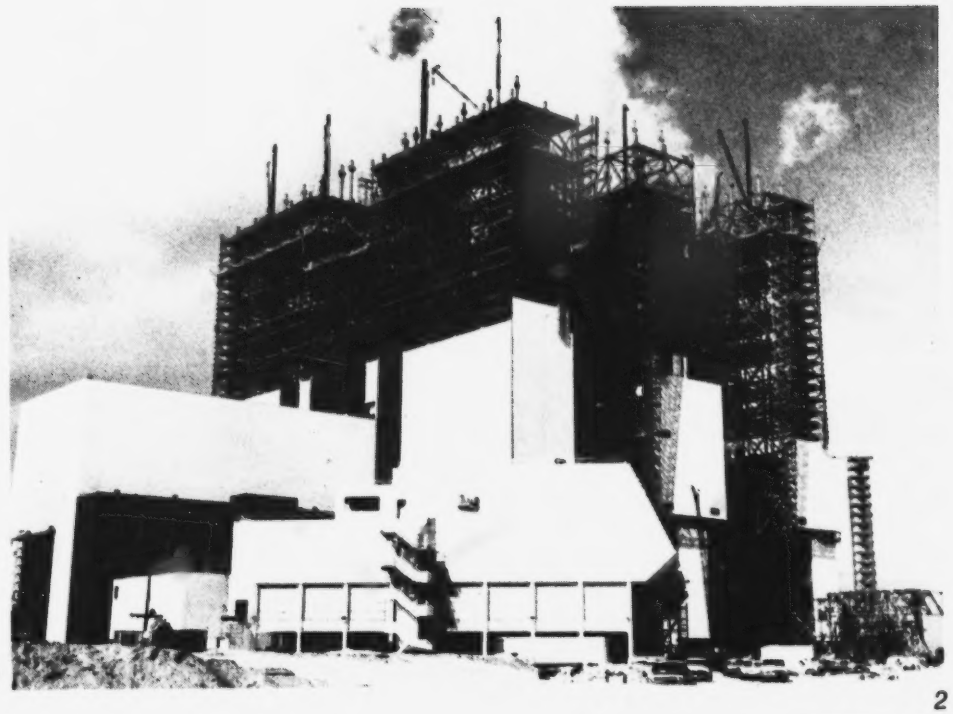
And so Apollo began. A three-man crew became the unit around which two spacecraft—a command and service unit and a two-man lunar lander—would be developed. The spacecraft would be two parts of a modular approach to the Apollo flight system, space flight building blocks that could be stacked together to meet mission requirements.

A few paragraphs describe Apollo, but the statistics almost defy the imagination. Huge test stands were built by the Marshall Space Flight Center to hold down more than seven-million pounds of thrusting rocket while thousands of complex measurements were made. NASA's entire Manned Spacecraft Center was organized, built from the ground up, and manned to plan and support the program.

Four completely instrumented ships were built to augment the land-based tracking and data acquisition network, to which new land stations were added around the world.

At Kennedy Space Center, a new launch area was cleared and constructed. The Vehicle Assembly Building (VAB), reaching 525 feet above the flat Florida beach, was built as part of a bold concept for indoor assembly of the entire Apollo flight system—spacecraft and launch vehicle—on a mobile launcher. The launcher and the assembled Apollo/Saturn V would be moved from the VAB by an enormous crawler, the world's heaviest tracked vehicle, along a three and one half-mile roadbed to the launch site.

New test stands, new buildings, new tracking systems, new ground facilities of all kinds—these had to be developed for the Apollo program. They constitute a formidable national resource, capable of meeting any requirements this country has for space flight.



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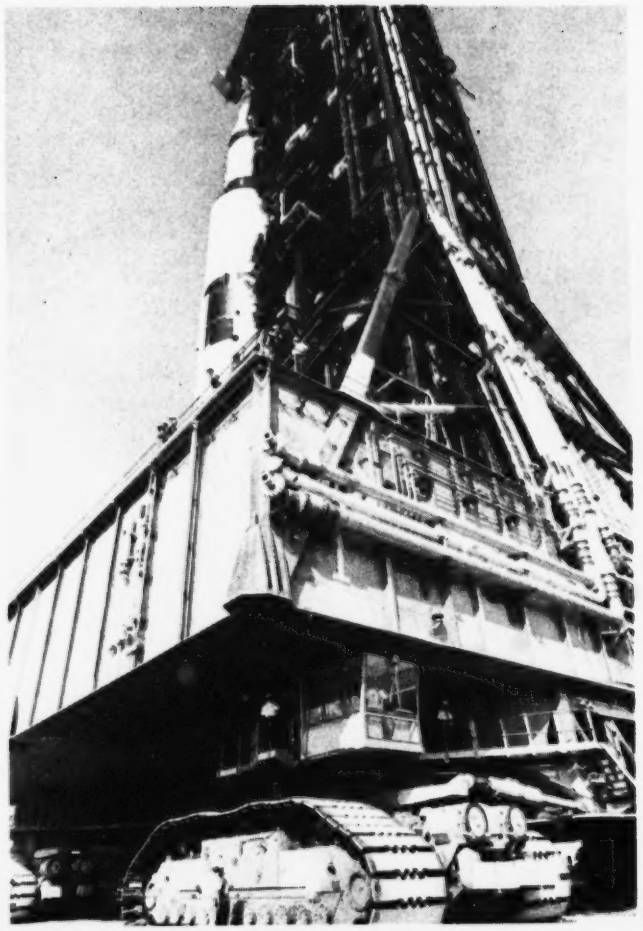

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1. Under construction, the Vehicle Assembly Building (VAB) takes form near NASA Launch Complex 39.

2. Four Apollo/Saturn V Moon rockets, each towering 363 feet, can be assembled at once in one of the largest—by volume—buildings in the world, the Vehicle Assembly Building (VAB).

3. Apollo 8 looms above crawler-transporter. Each of the 60 steel links in the crawler's treads weighs about a ton.

4. The first stage of a Saturn V launch vehicle being lowered into position in the Vehicle Assembly Building (VAB).

5. Inside Firing Room 3 of the Launch Control Center at the Kennedy Space Center.

5

ROOM FOR THREE

Their first code names were Spider and Gumdrop, names that millions heard during transmissions from Apollo 9.

Formally they are called the lunar module (LM) and the command and service module (CSM), and are the two key spacecraft in the Apollo program.

Behind them lies the developmental experience that first produced the bell-shaped Mercury one-man spacecraft, six feet in diameter, seven feet high, and weighing about 3,500 pounds. The succeeding Gemini two-man craft retained the basic bell shape, but required extra space to support two men on longer flights. It was about 7½ feet in diameter, stood about 18 feet high and weighed about 4,800 pounds.

There is a family resemblance between these earlier spacecraft and the command portion of the CSM. They share a slightly rounded base, a heat shield to insulate the returning astronauts from the burning heat of re-entry. Seated with backs to the shield, the astronauts are protected by outer layers of ablating material, a substance that absorbs the frictional heat of re-entry by melting, boiling and evaporating.

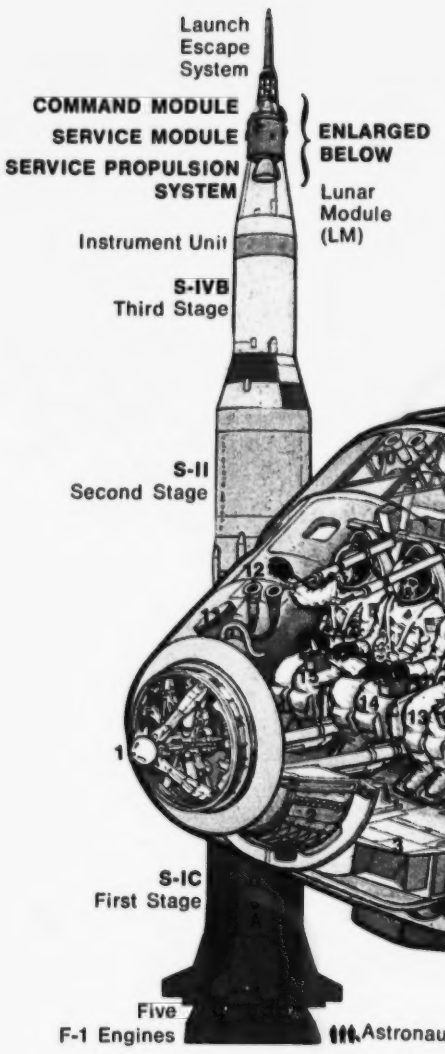
The command module itself stands about 12 feet high, has about the same diameter, and weighs about 13,000 pounds. Packed into its interior are the astronaut couches, all their food, all their instruments and radios and cameras and space suits, their flight plans and helmets and toothbrushes, their sunglasses and the recovery parachutes.

The base of the command module is attached to the service module for most of the trip to the Moon and back. The cylindrical service module and its rocket engine are separated just before re-entry into the atmosphere. The command module carries the astronauts to the recovery area and the empty service module breaks up and burns on re-entry.

The lunar module was designed with one thought in mind: Efficient performance in space. It can't take the decelerations and frictional heat of re-entry into the Earth's atmosphere. It is carried into space inside a protective adapter that spans the transition between the launch vehicle and the CSM.

The lunar module is about as high as a two-story house, weighs 16 tons and looks like—well, like a spider. It has black and gold markings to absorb and reflect the heat of the Sun.

The lunar module itself is modular; complete, it makes the descent to the Moon on the thrust of a rocket engine in its belly. Its spindly legs support the module on the lunar surface. Afterwards, the astronauts leave the Moon in the ascent stage, the upper module of the lunar lander. The lower portion stays behind, serving as a launch pad for the liftoff.



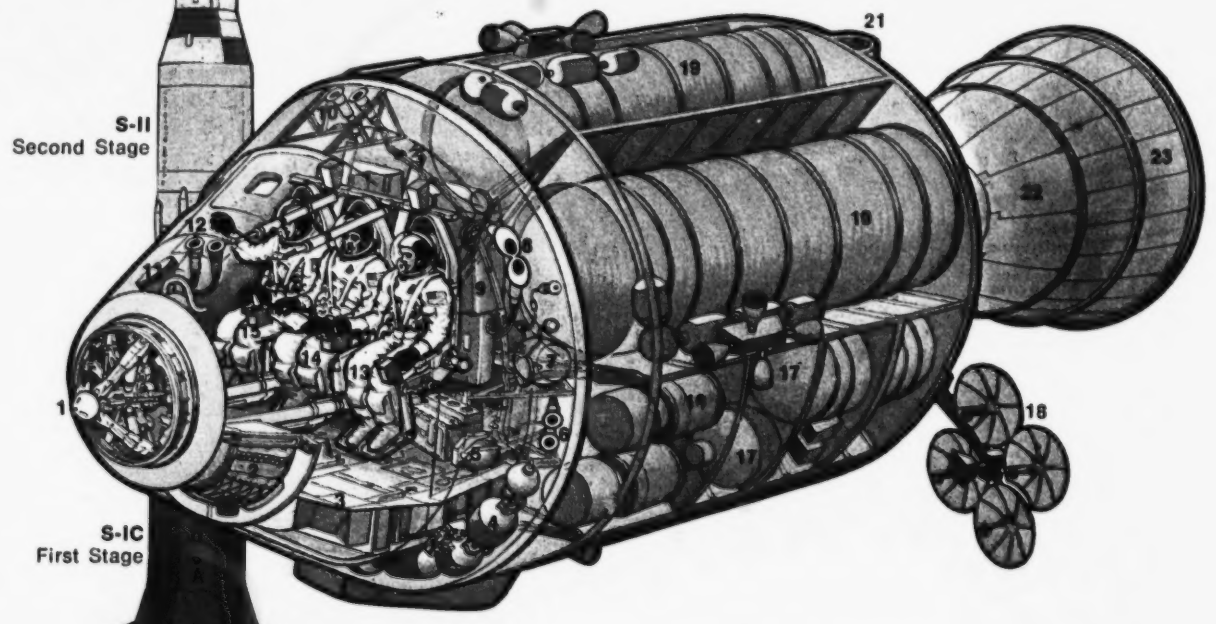
1

APOLLO SPACECRAFT AND SATURN V LAUNCH VEHICLE

COMMAND MODULE
1 Docking Probe
2 Main Parachutes
3 Food Compartment
4 Reaction Control Fuel Tanks
5 Fire Extinguisher
6 Yaw Jets
7 Drinking Water
8 Roll Jets
9 Storage Compartments
10 Pitch Jets
11 Drogue Parachutes
12 Pitch Jets
13 Commander
14 Command Module Pilot
15 Lunar Module Pilot

SERVICE MODULE
16 Fuel Cells
17 Liquid Oxygen And Hydrogen Tanks
18 High-Gain Antenna
19 Service Module Engine Fuel Tanks
20 Reaction Control Jets
21 Fuel Inlet

SERVICE PROPULSION SYSTEM
22 Service Module Engine
23 Nozzle



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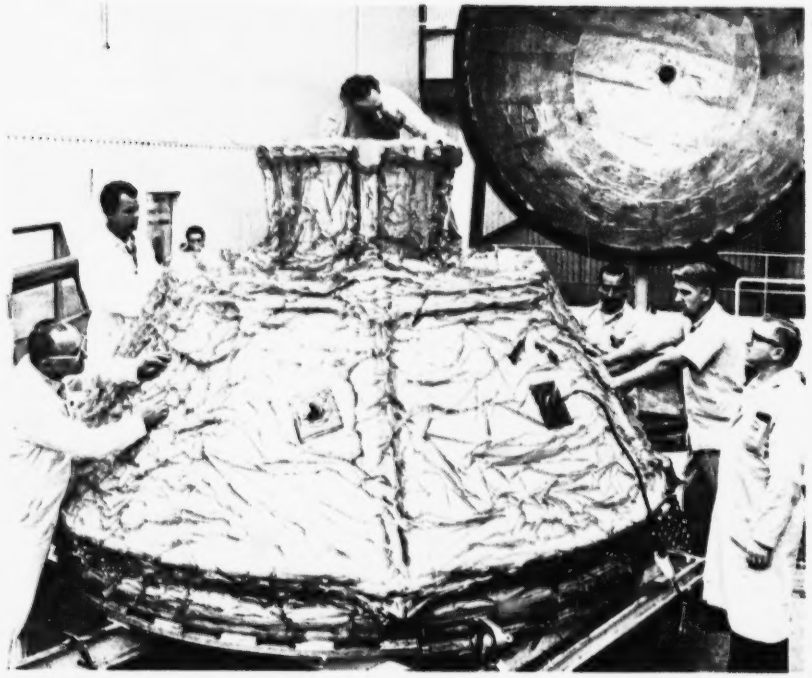

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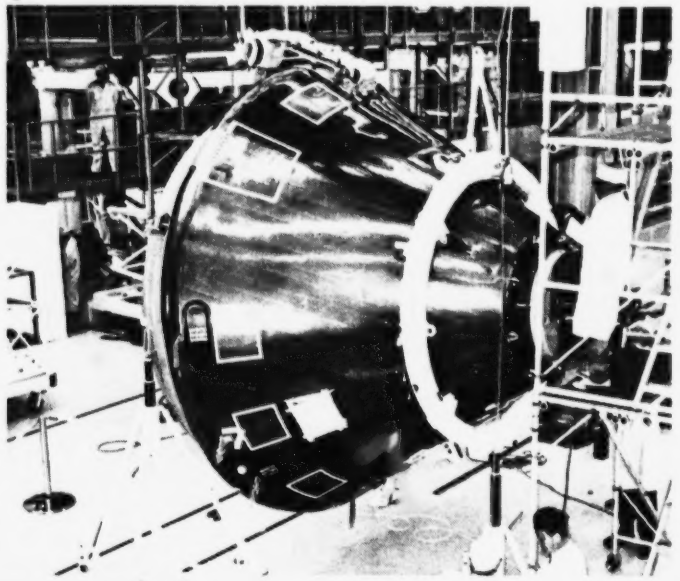

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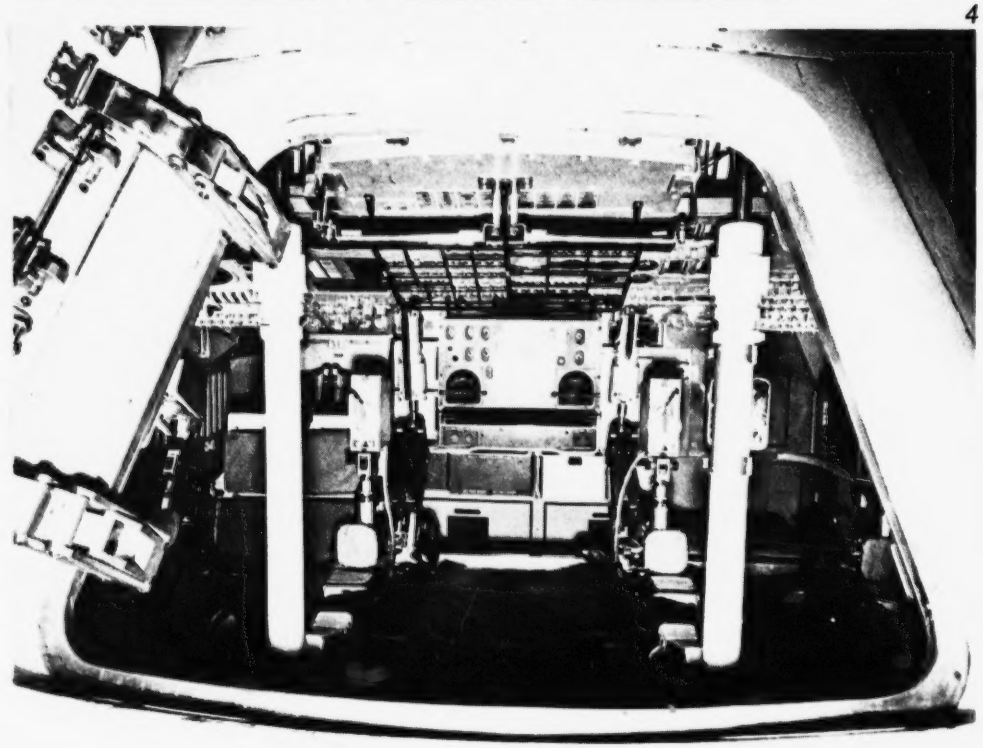

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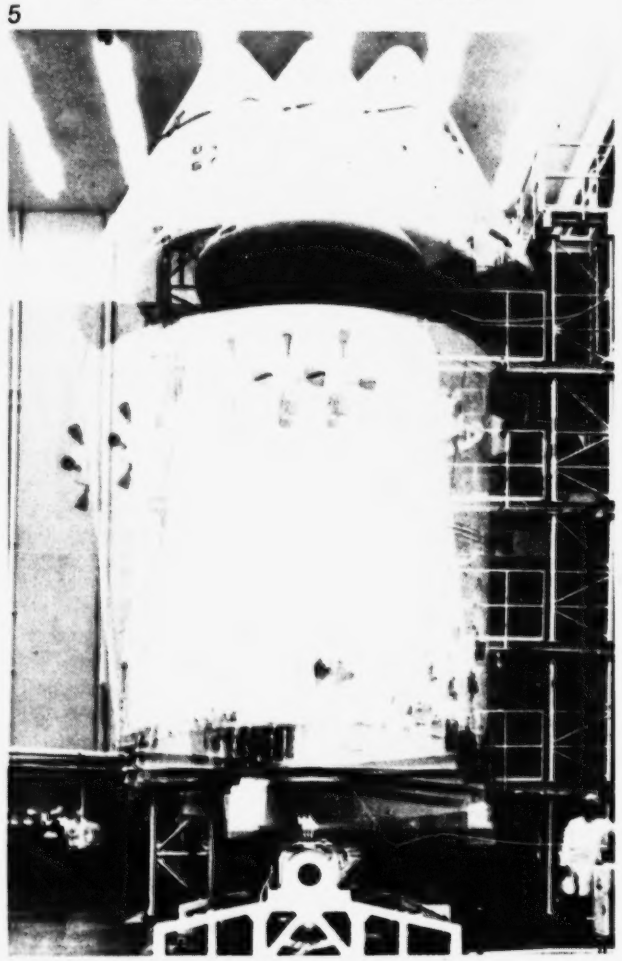

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1. X-ray view of the Apollo command and service module.

2. The Apollo command module forward wall being prepared for bonding and curing of primary covering material.

3. The Apollo 8 command module is mounted on the weight and balance rig for final systems evaluation tests.

4. Mockup of the Apollo command module, as seen through the hatchway. The three astronaut couches are seen below the main display panels.

5. Rock 'n' roll test of the command and service module checks guidance and navigation units.

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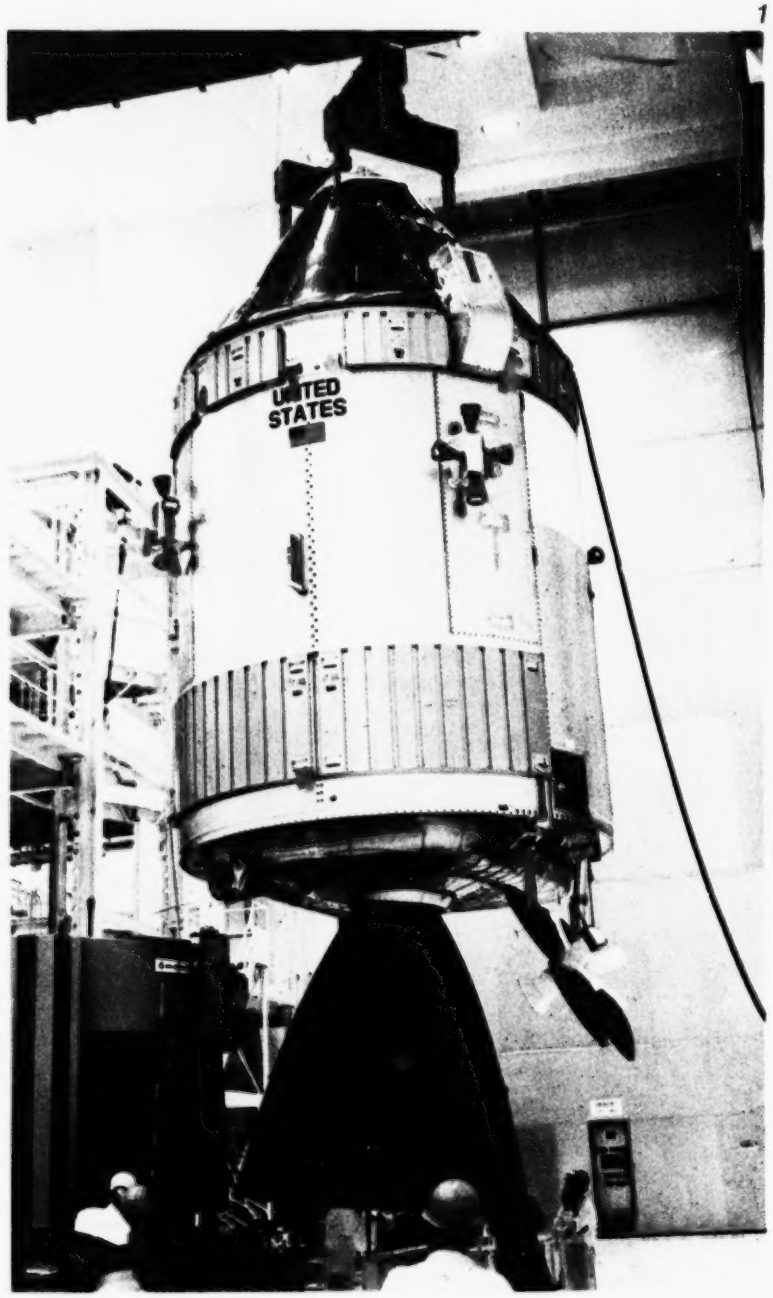
UNITED
STATES

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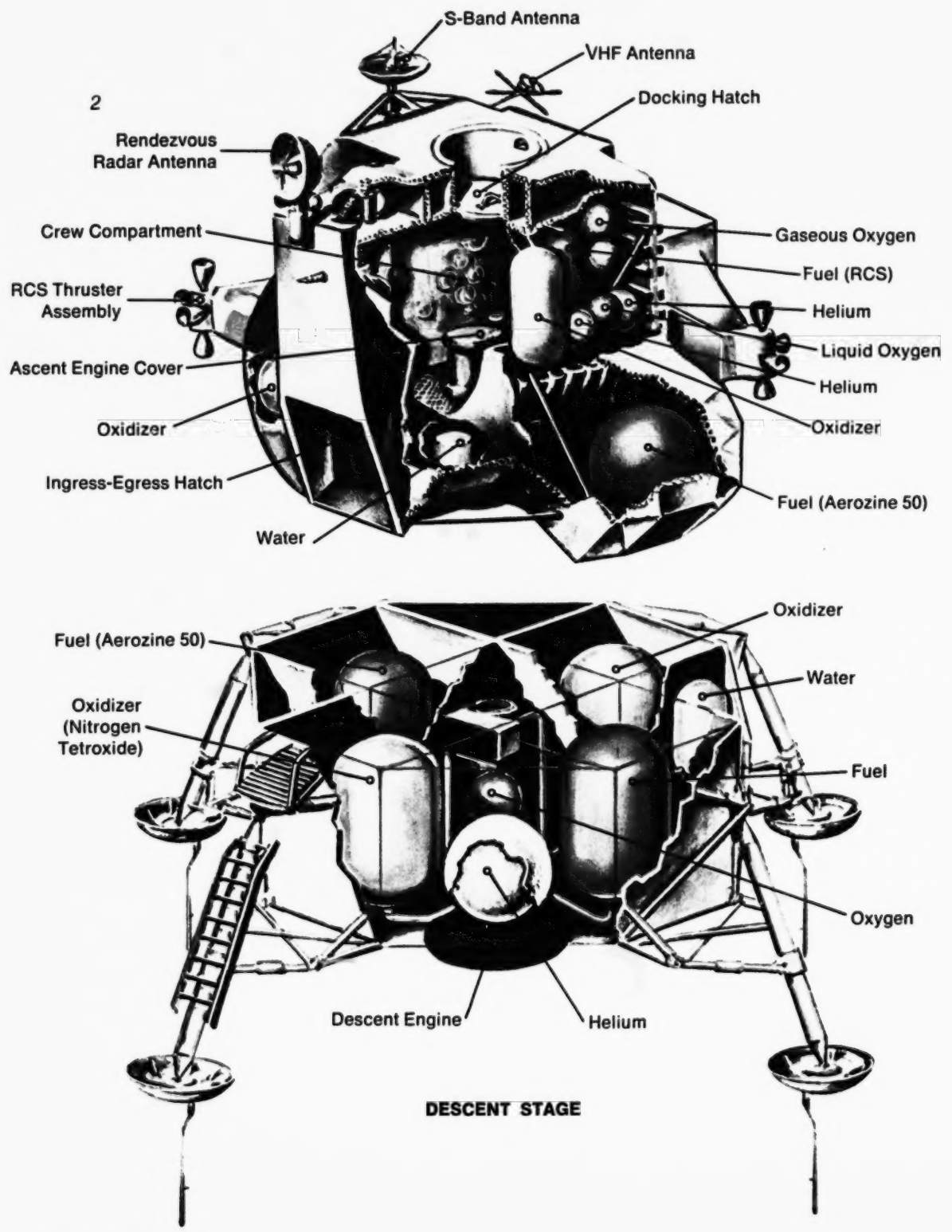
ASCENT STAGE
S-Band Antenna
VHF Antenna
Docking Hatch
Rendezvous Radar Antenna
Crew Compartment
RCS Thruster Assembly
Ascent Engine Cover
Oxidizer
Ingress-Egress Hatch
Water
Gaseous Oxygen
Fuel (RCS)
Helium
Liquid Oxygen
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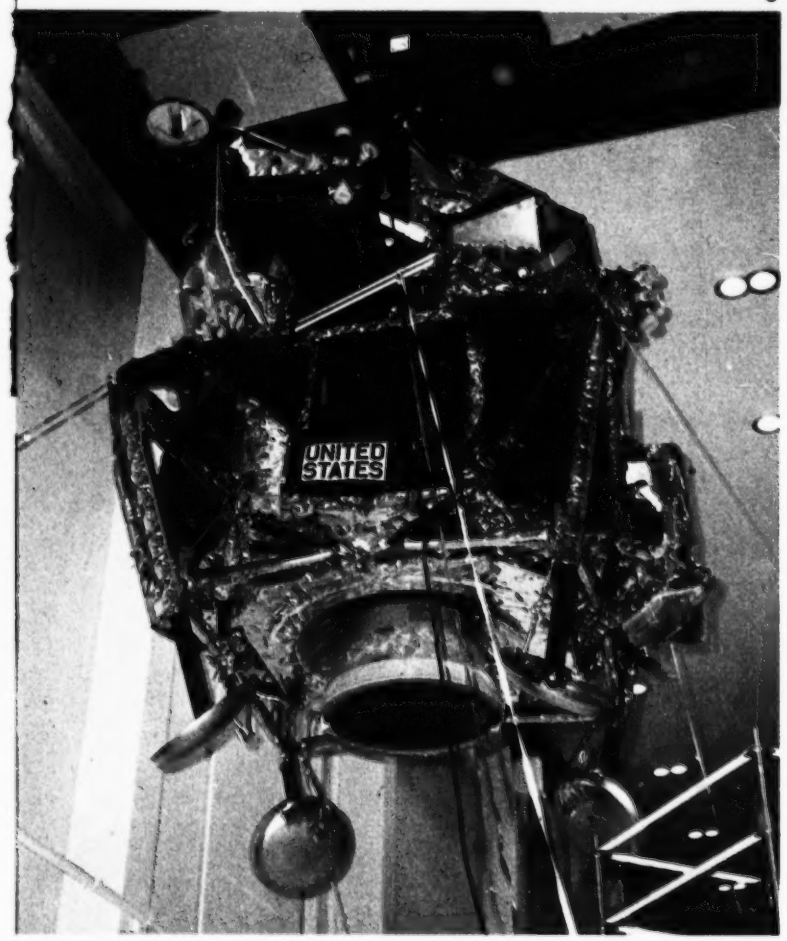

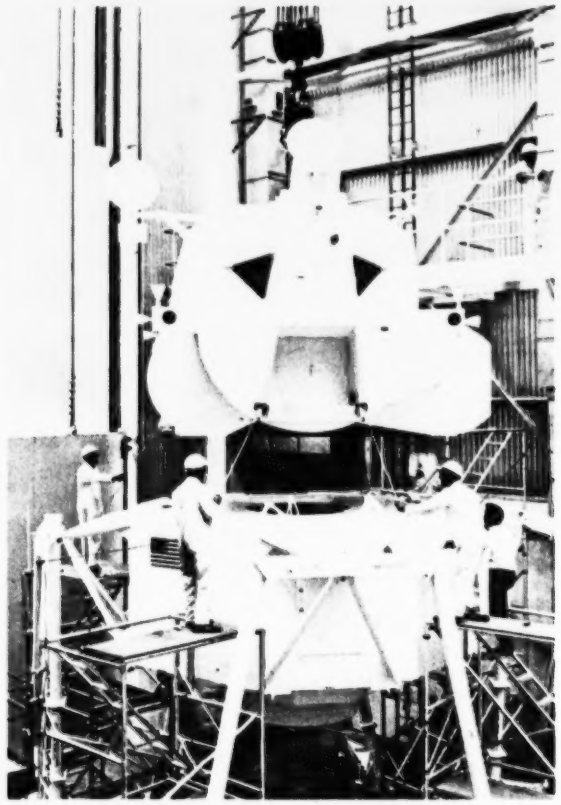

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1. The Apollo 10 command and service module being moved to the work stand before assembly to its Saturn V launch vehicle.

2. Cut-away view of ascent and descent stages of the lunar module.

3. The Apollo 10 lunar module is made ready for mating to the spacecraft's lunar module adapter.

4. A mockup of the Apollo lunar module ascent and descent stages is put together at Kennedy Space Center.

5. An overhead crane in the Vehicle Assembly Building hoists the Apollo 10 spacecraft in preparation for mating to its Saturn V launch vehicle.

6. The lunar module being checked in its assembly stand.

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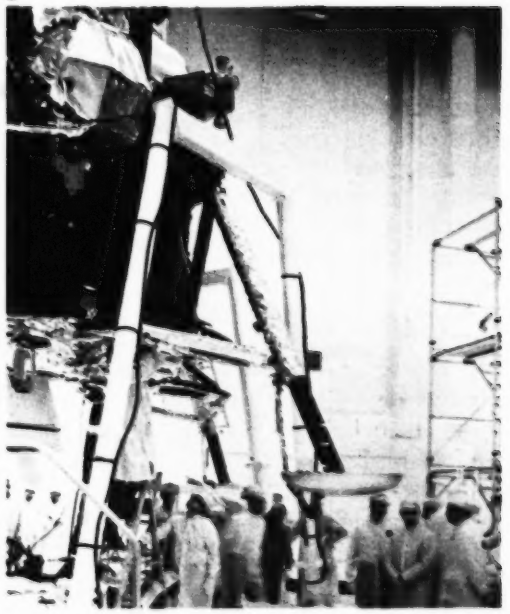

6

POWER TO GO

The lunar journey starts with the Saturn V's roaring thrust of 7½ million pounds, spewing from the throats of five rocket engines.

Saturn V is six million pounds of launch vehicle, standing as high as a 36-story building, shaking the Earth with the raucous rumble of its rockets that deliver more thrust than 100 modern jet airliners.

Saturn V also is modular, a series of powered stages and adapters or transition pieces. As the launcher for the final group of Apollo missions to the Moon, Saturn V requires three powered stages, stacked one atop the other in a towering assembly that dwarfs previous launch vehicles.

Mercury spacecraft first were lofted by the Redstone rocket and later by the Atlas rocket, chosen because they were readily and economically available, and their performance had been proven.

Gemini required more thrust for the larger and heavier two-man spacecraft. Again an available rocket was chosen. Modified and man-rated, the Titan II launched all ten Gemini flights.

Apollo imposed new requirements. A Saturn I, the first Apollo launch vehicle for unmanned, instrumented test firings, was an outgrowth of an earlier booster rocket. Saturn 1B used a Saturn I first stage, combined with an entirely new second stage. It carried unmanned spacecraft into orbit, and then boosted the first manned Apollo spacecraft into an Earth orbit for a successful check of the Apollo system in long-duration space flight.

The Saturn IB stood about 141 feet high and weighed about 1½ million pounds. It dwarfed the earlier launch vehicles. But Saturn V was to be a giant among giants, topping 363 feet.

That height is built on a first stage containing five F-1 rocket engines. Next module is an interstage, with small rocket engines and electronics.

The second powered stage contains five J-2 engines, which together develop more than one million pounds of thrust. Above is the third powered stage, with a single J-2 engine. A transition piece joins that stage to the instrument section, and another transition piece, containing the LM, joins the combined service and command modules to the bulk of the Saturn V launch vehicle.

Poised atop the entire assembly is the escape tower, a rocket-powered structure that will lift off the command module if there is trouble on the pad at launch or in the first few seconds of flight.

One measure of the pace of progress: The thrust of the escape rocket engine is twice that of the original Redstone rocket that launched the first Mercury manned flights.

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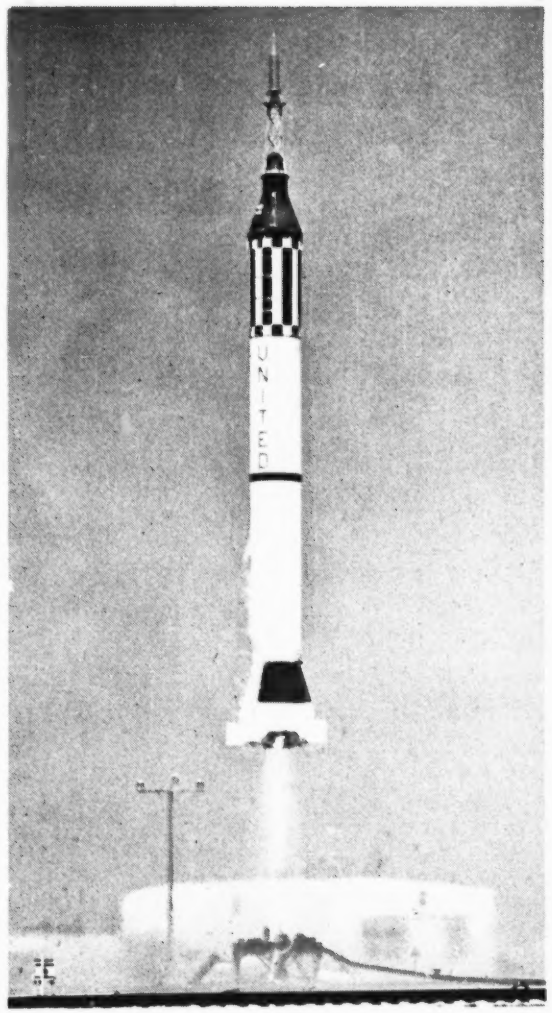

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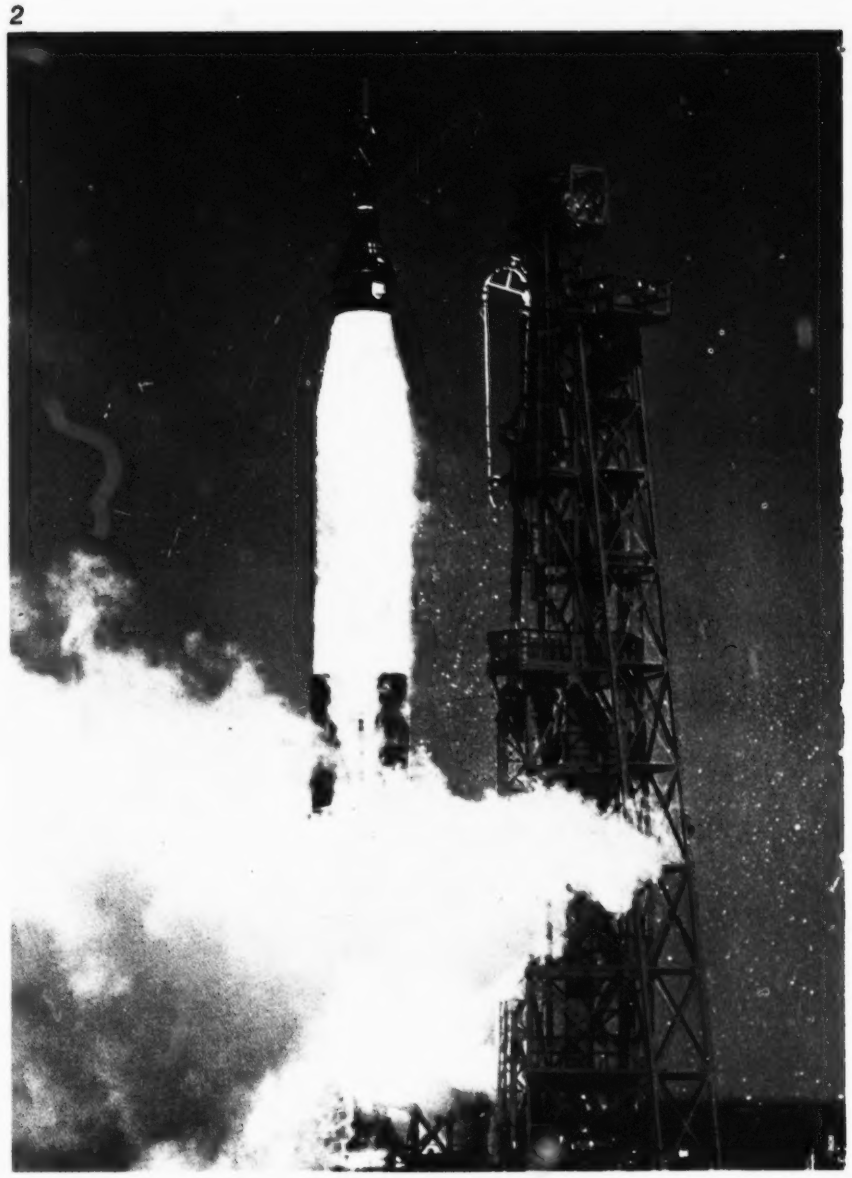

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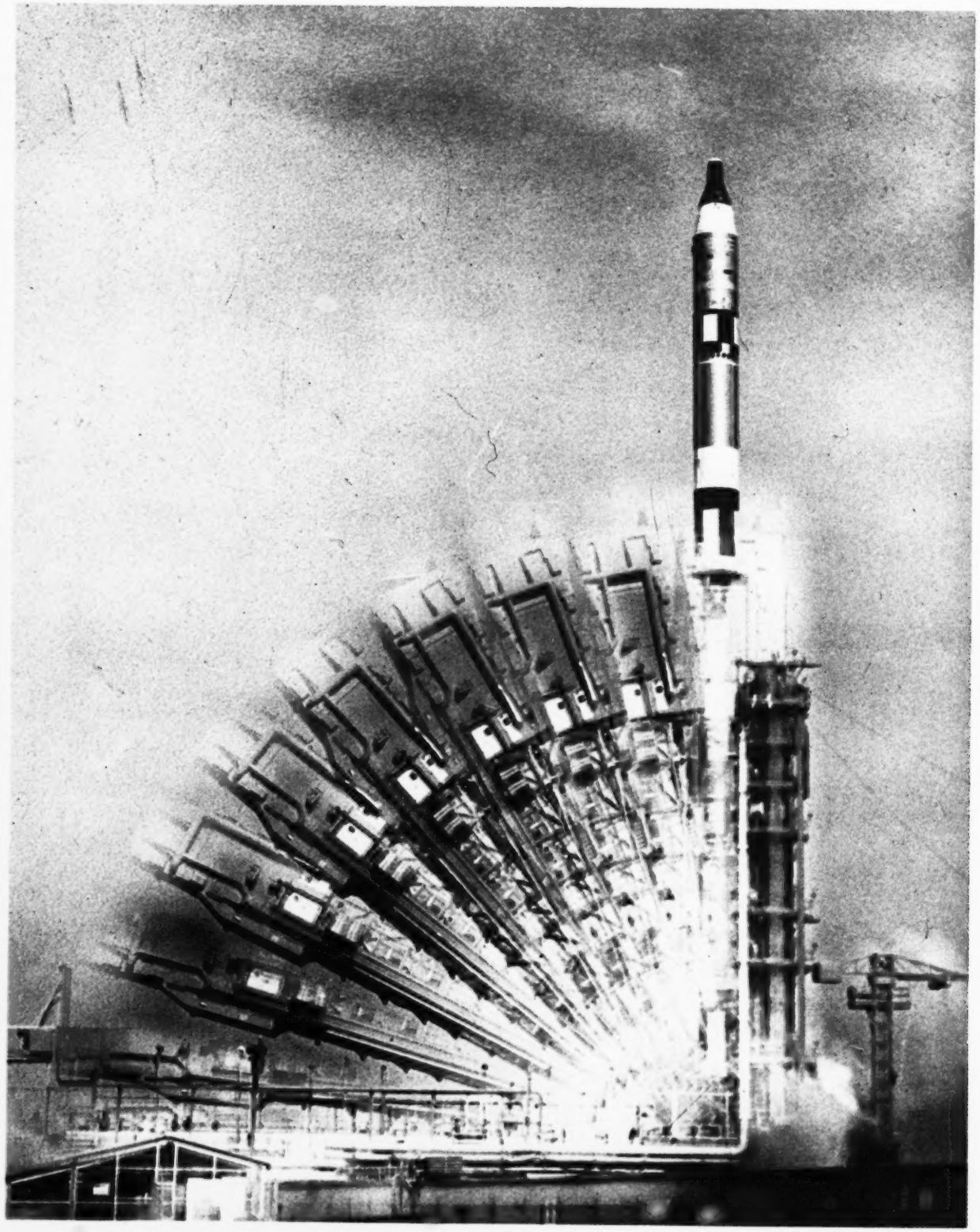
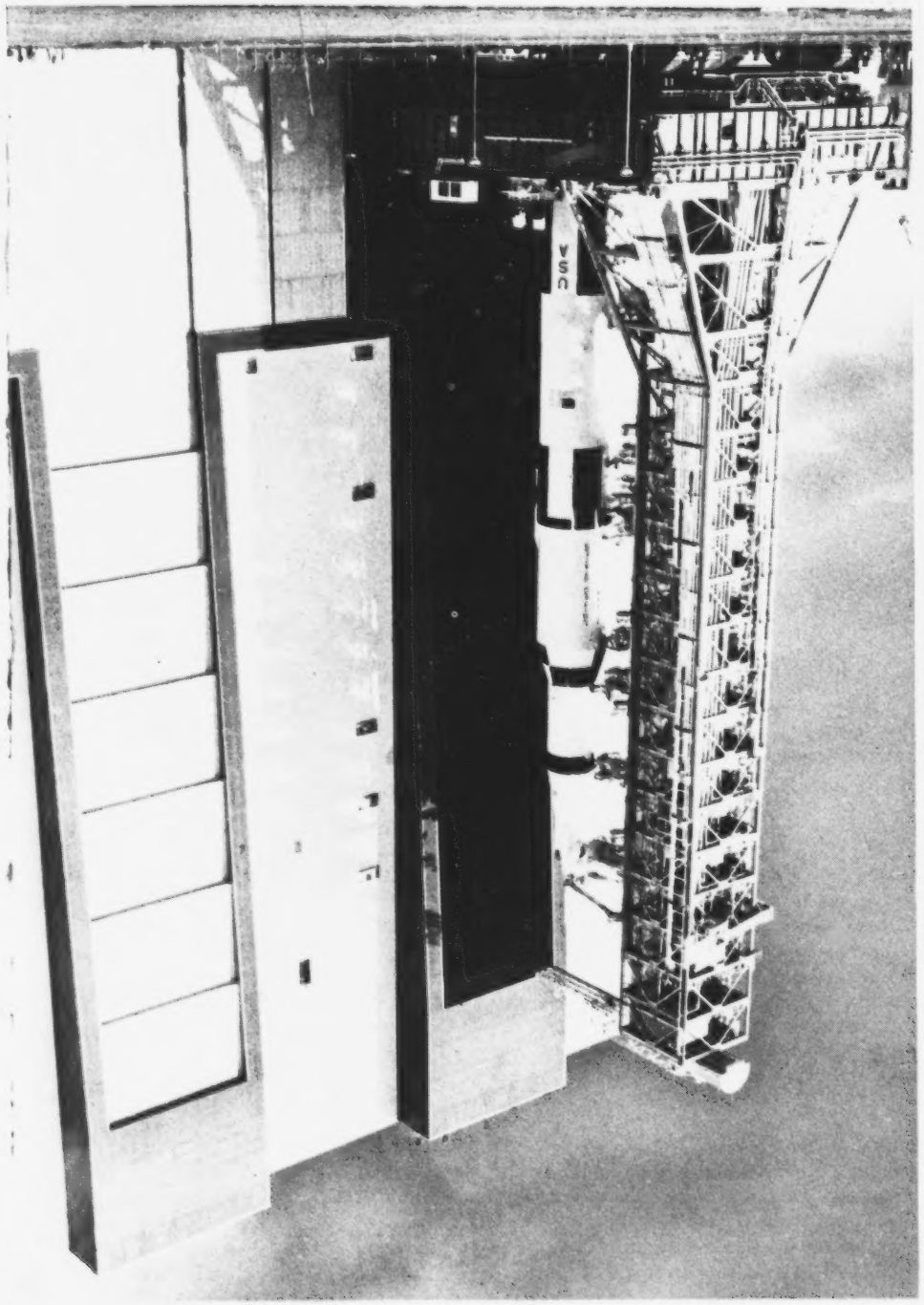


1. Redstone launch vehicle carried Mercury spacecraft into suborbital flight.

2. Atlas rocket launched Mercury Astronaut Glenn into Earth orbital flight.

3. This multiple exposure photo shows the action of the erector gantry before lift-off of the Gemini-Titan launch vehicle.

"I feel personally that the general goals of the space program are a natural continuation of the human adventure. It is unthinkable that our society, particularly Western society, can ignore this challenge."—Dr. Frederick Seitz, President, National Academy of Sciences, in Congressional testimony, 1963.



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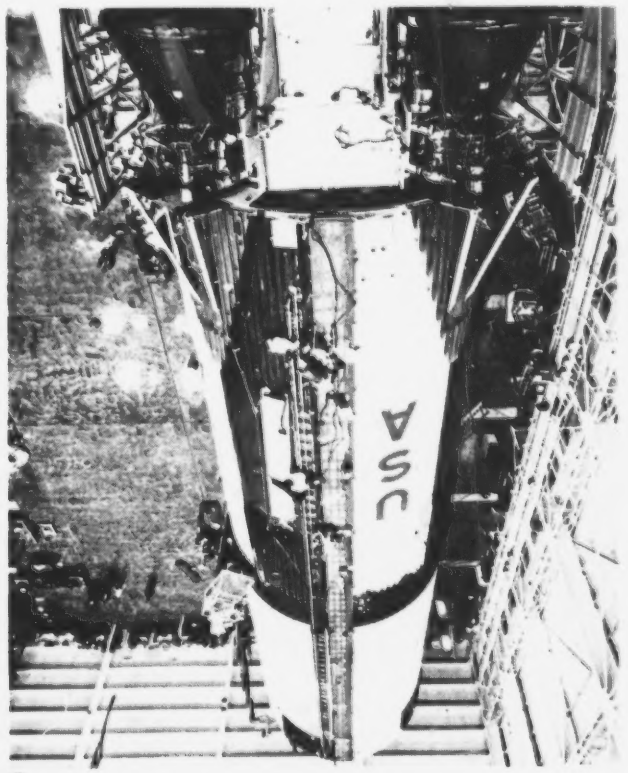

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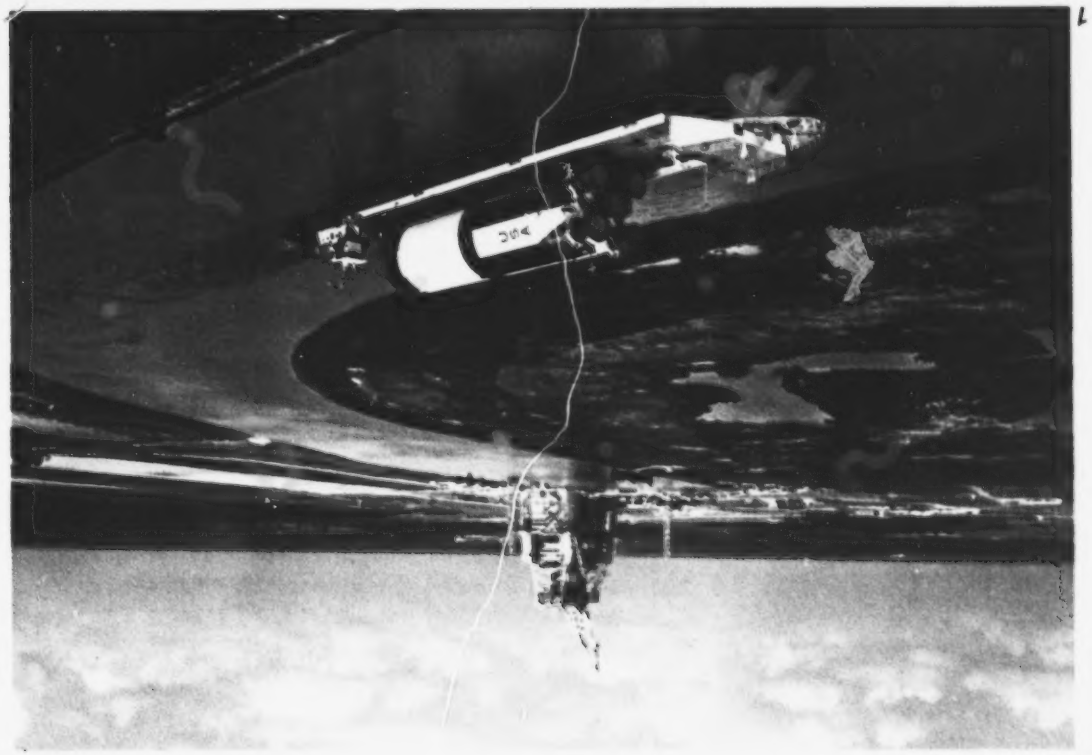

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1. Static firing completed, this Saturn V first stage is barged away from test stand at Mississippi Test Facility.

2. Saturn V first stage rocket in final assembly at the Marshall Space Flight Center.

3. First stage of the Saturn V is hoisted into position inside the VAB.

4. Standing on its crawler-transporter, the Apollo/Saturn V Moon rocket rolls out of the VAB on its way to the launch pad.

5. Apollo/Saturn V heads for space.

6, 7, 8. Apollo/Saturn V Moon rocket is launched into space, as photographed from the 360-foot level of its umbilical tower.

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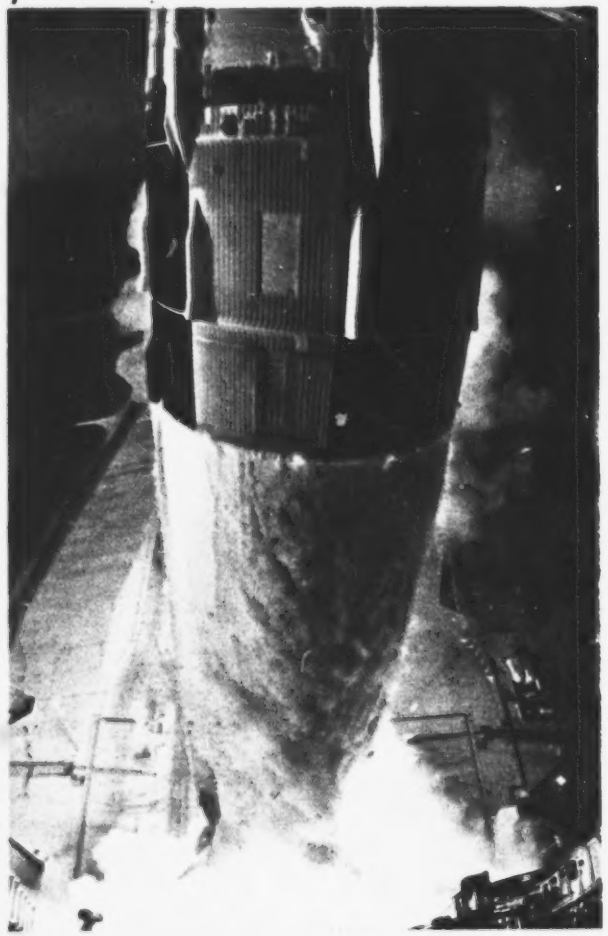

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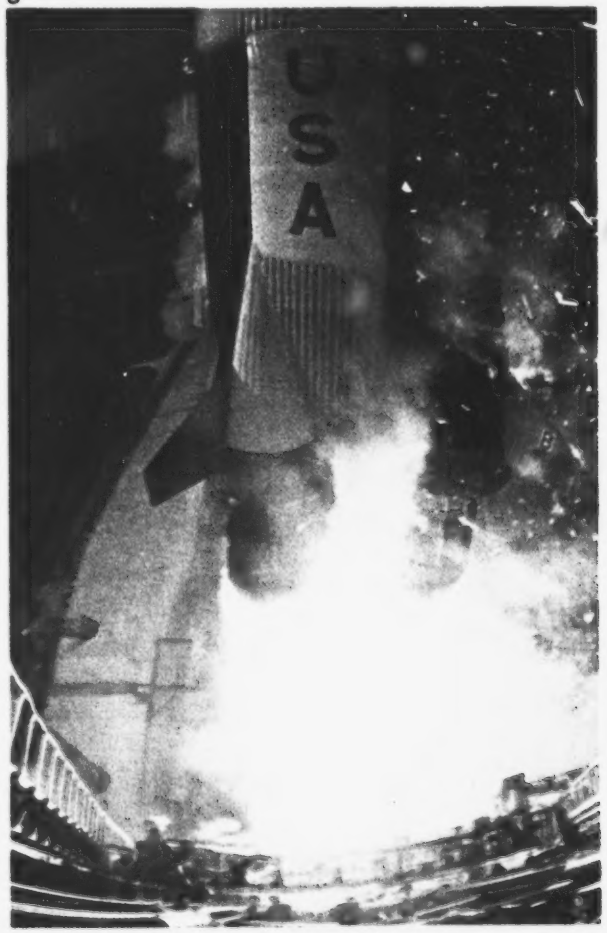

7

SPACE TRAVELERS

The crews designated for Apollo missions are drawn from a group of 50 astronauts now participating in the NASA manned space flight program. Originally chosen from the lists of qualified military test pilots, the astronauts brought their specialized flight skills to the program. In later groups, scientists-astronauts were selected, and then received flight training to round out their experience.

But there was to be much more to do than fly a spacecraft. Each astronaut, already highly qualified technically became a specialist on some phase of manned space flight, such as communications, space suit design or spacecraft layout.

Their training is rigorous, exacting and long. Exercise regimes maintain them at their physical peaks. Constant practice of missions on simulators, training devices and on paper sharpen their skills further. They have experienced re-entry forces in a whirling centrifuge, and weightlessness in skillfully flown aircraft. They maintain their own flight proficiency in jet planes.

Pilot proficiency was important, because from the start of the manned space flight program, NASA had rejected the idea that the occupant of the spacecraft would only be a passenger, along for the ride. From the first Mercury flights, all spacecraft were capable of being flown manually. And in each of the orbital Mercury flights, it paid off; the astronaut had to take control of the spacecraft to complete the mission successfully.

Putting a man in a spacecraft and expecting him to work in that environment—and in the more alien environment of space—demands remarkable clothing. The Mercury astronauts had to be protected only against catastrophic loss of pressure in the spacecraft. Gemini crews needed more protection; their suits had to be qualified for "space walks," planned for those flights and necessary for later Apollo landings on the Moon.

But the best suit is no suit, the Mercury and Gemini pilots found. So the Apollo spacecraft has an environment like that of a modern airliner, pressurized and air-conditioned, giving the crew more freedom of motion.

Outside the spacecraft, the fierce environment of the Moon will be countered by a full-pressure suit, a complex garment with extra layers of fabric as armor against possible micrometeroid hits.

The pressure suits have a tendency to stay rigid in the vacuum of space. Just to move in a pressure suit is hard work, and the schedules for all the space walking and lunar surface exploration in the Apollo program are interspersed with numerous rest periods.

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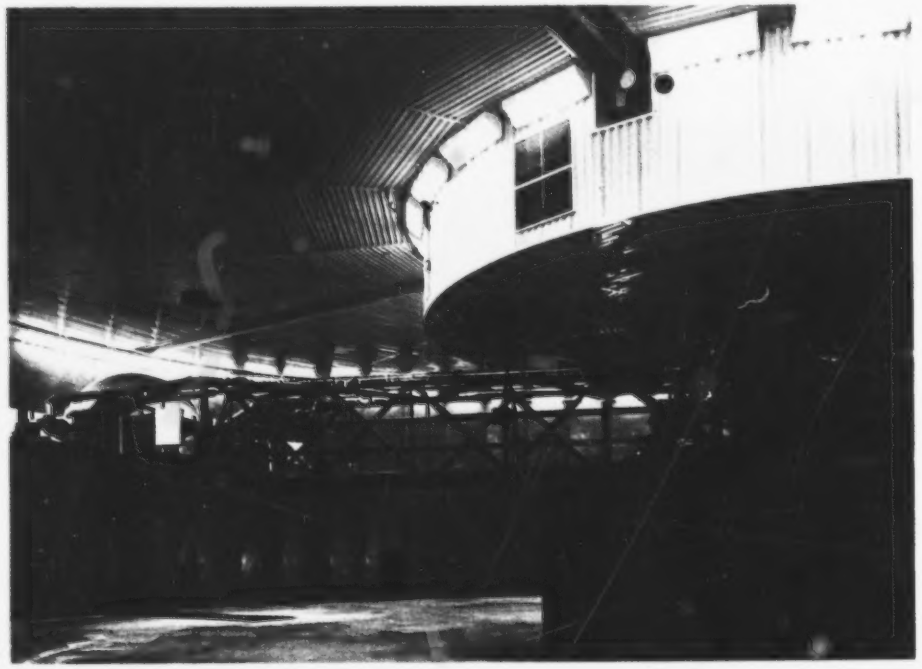

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1. Apollo 10 Astronaut Tom Stafford exercises for fitness.

2. Astronaut Eugene Cernan maintains his flight proficiency in high performance jet aircraft.

3. A background in geology will be useful in lunar exploration. Shown is Astronaut Stafford on field trip.

4. Astronaut Aldrin practices extravehicular work underwater to simulate zero-gravity conditions.

5. Flight acceleration centrifuge at the Manned Spaceflight Center.

6. Apollo Astronauts practice their missions in this simulator at the Kennedy Space Center.

7. Lunar Landing Research Vehicle was flown in test simulating descent to the Moon.

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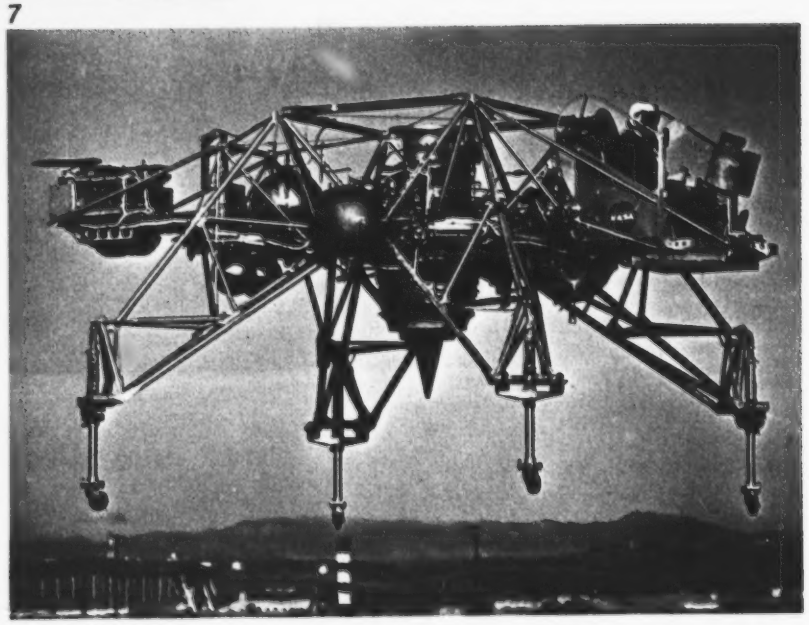

8

SCOUTING THE MOON

Before Apollo's astronauts land on the Moon, other major NASA scientific programs will have produced detailed maps, photographs and physical data about Earth's neighbor.

Ranger, Lunar Orbiter and Surveyor spacecraft have reached, touched and explored the Moon in programs of unmanned lunar trips that began almost a decade ago.

Three Ranger spacecraft produced more than 17,000 photographs of the lunar surface; one of the Rangers sent the first live television pictures from near the Moon. There was another benefit from these spacecraft; their pictures confirmed the existence of large, smooth areas suitable for lunar landings.

The Rangers were hard-landers, destroyed on impact with the Moon. Surveyor, a series of soft-landers, was planned first as a scientific program, but was later expanded to include tasks specifically related to engineering needs of Apollo.

The first Surveyor launch was successful; more than 11,000 photographs of the Moon were transmitted back to Earth for study. The second Surveyor failed. The third bounced after initial touchdown, and photographed one of its own intermittent footprints which verified assumptions that the Moon's surface could bear walking men. It also took more than 6,000 other pictures of the lunar landscape, sampled the surface by digging four trenches, feeling the surface and testing a piece of the surface to determine its strength.

Later Surveyor spacecraft continued to transmit photographs, sample the surface and supply confirming data for Apollo. But there was a need for photographic mapping of the Moon, which defined the requirements for a new spacecraft, the Lunar Orbiter.

Its primary job was to survey possible landing sites. The first three Lunar Orbiters fulfilled that task by taking many photographs of potential touchdown points. The last two Lunar Orbiters were guided to look at broader areas of the Moon. The results were almost unbelievable. Detailed pictures of the lunar surface were transmitted back to Earth, to reveal more than 99 percent of the Moon's surface. The photographs were ten times as clear as the best that could have been obtained from an Earth observatory.

The pictures were invaluable to the Apollo program. But there was a major secondary benefit in the wealth of photographic data available. Astronomers, geologists, seismologists and other scientists now have an unequalled collection of new data on the Moon, to provide new insight into the lunar composition and structure.

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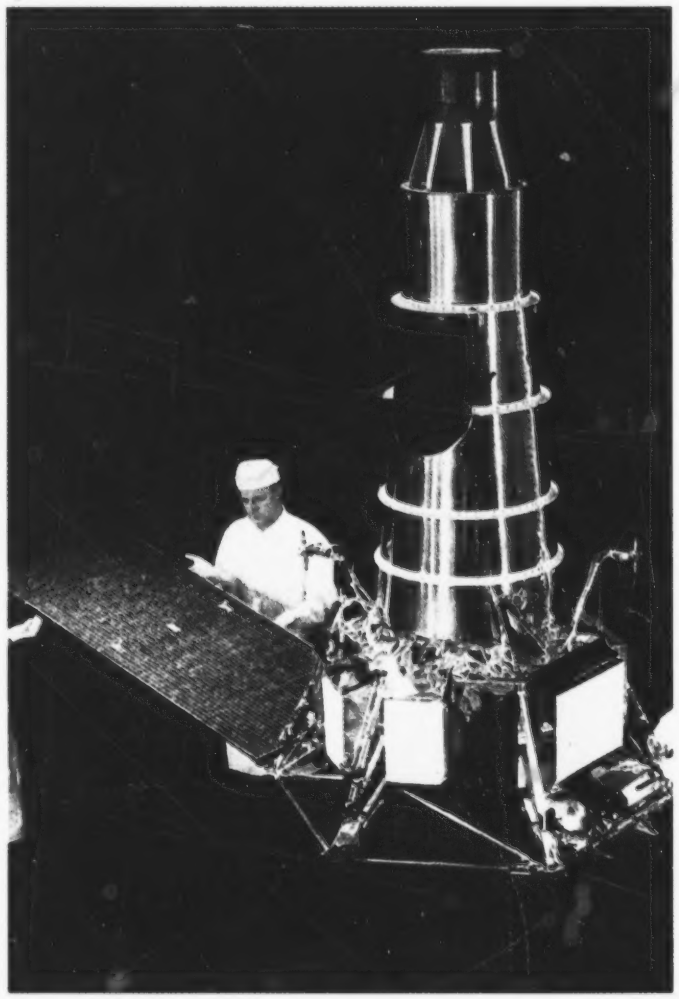

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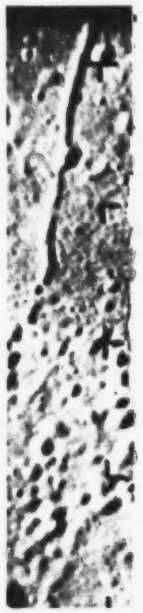

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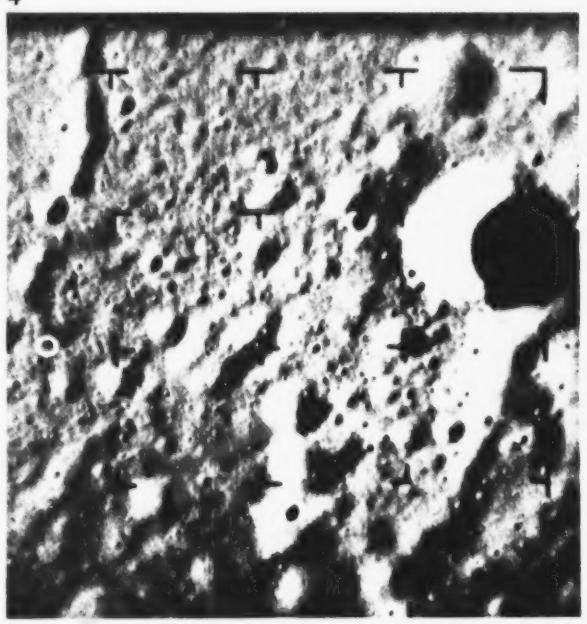

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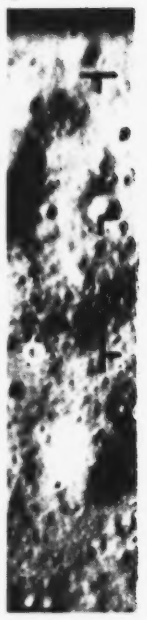

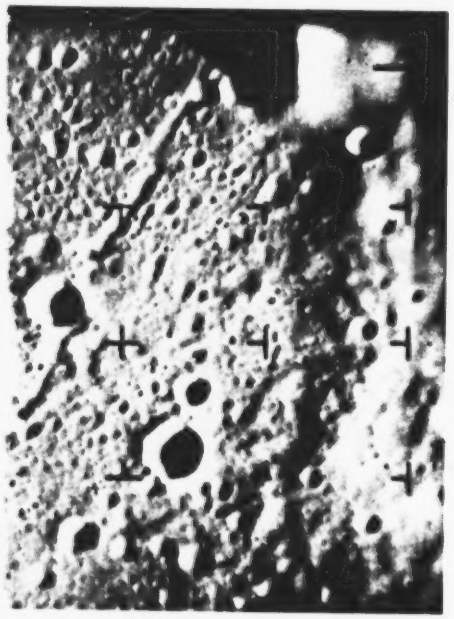

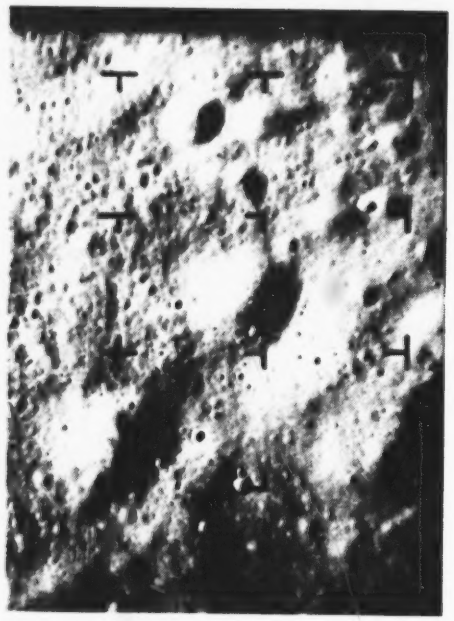

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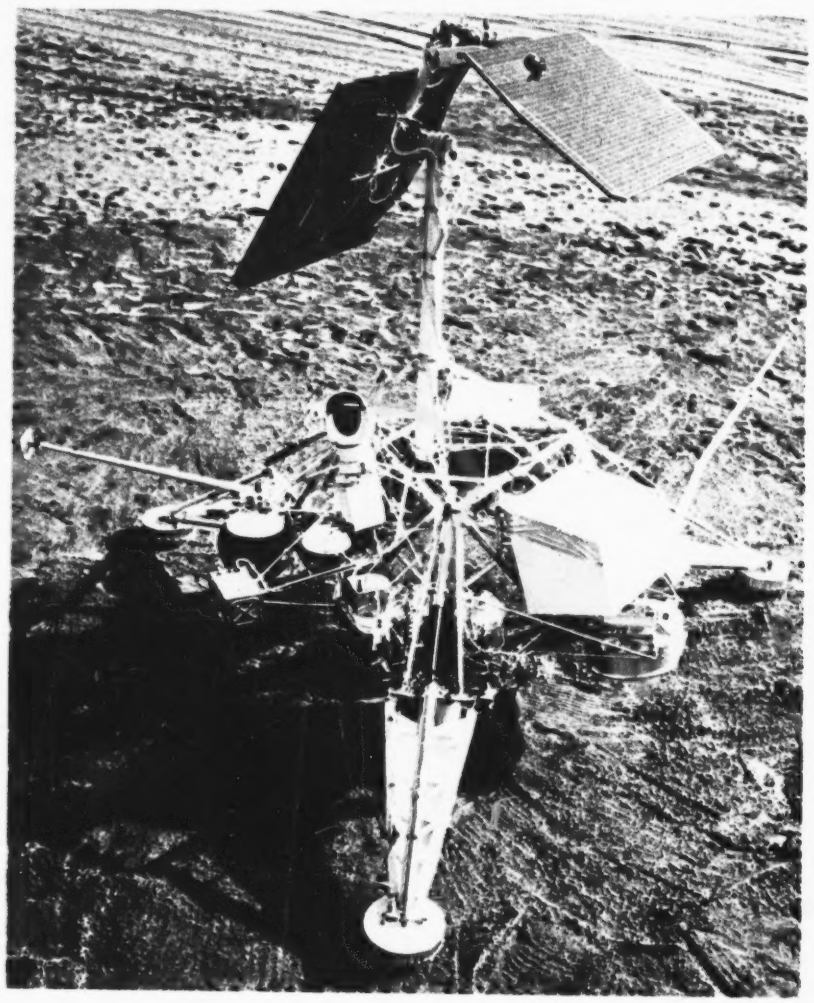

1. Ranger spacecraft receives a pre-flight check.

2, 3, 4, 5. Television photos from Ranger IX at altitudes above the lunar surface of: (2) 50.3 miles, (3) 35 miles, (4) 12.2 miles, (5) 4.5 miles.

6. Soft landing Surveyor spacecraft.

7. Photo mosaic taken by Surveyor VII shows the surface sampler digging a trench on the Moon.

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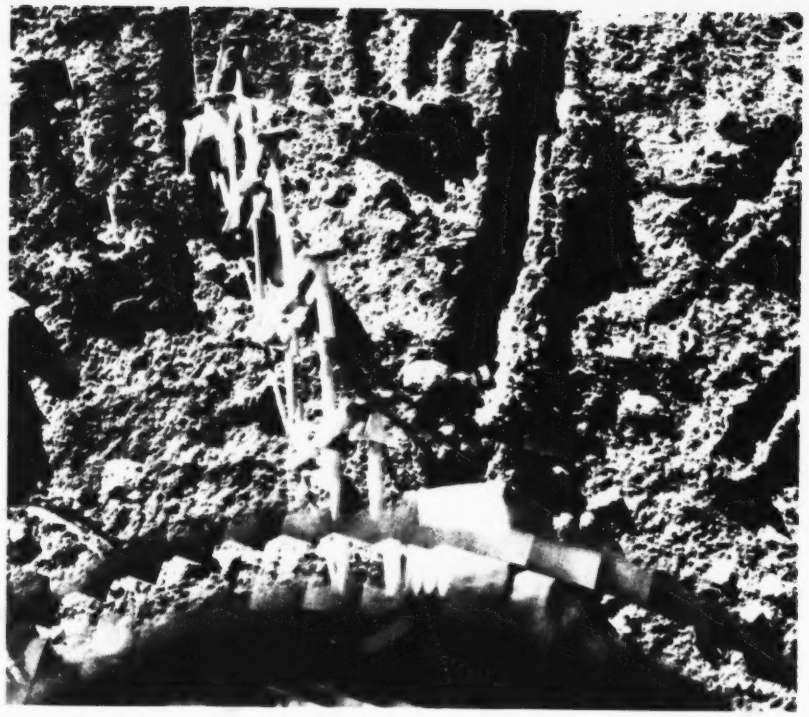

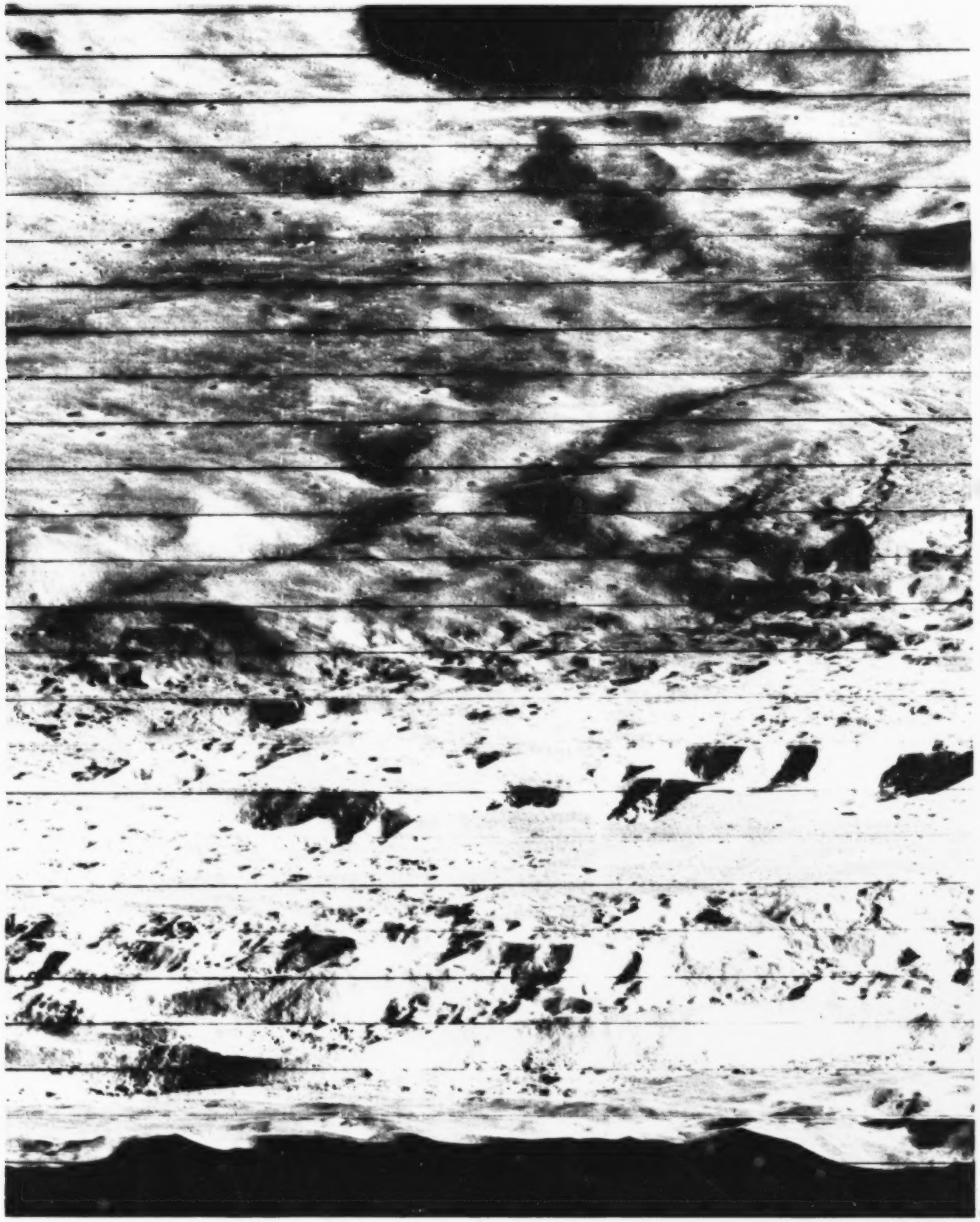

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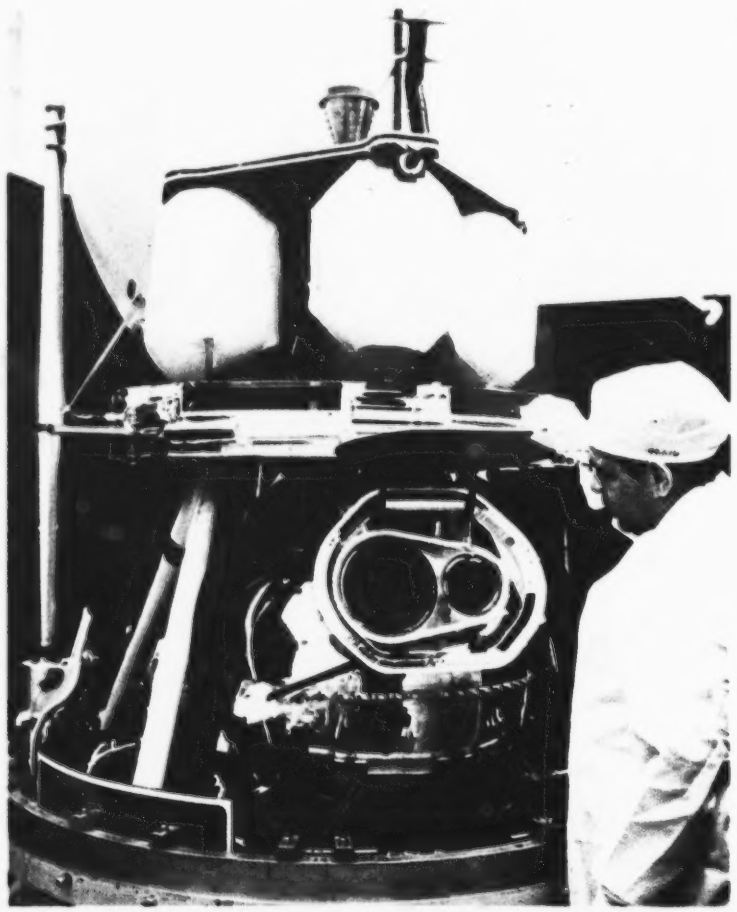

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1. Scientific device carried by Surveyor to help determine the chemical composition of the lunar soil, was deployed on the Moon.

2. The floor of the crater Copernicus, shown in this Lunar Orbiter II photograph, has 1,000-ft. high mountains projecting near the center.

3. Lunar surface material, placed on the footpad by Surveyor III's surface sampler, was photographed and converted into color image.

4. Protected by red dust covers, the camera lenses on Lunar Orbiter spacecraft are checked before flight.

5. Lunar Orbiter V's wide-angle camera photographed the crater Tycho from 135 miles above the Moon.

6. First Lunar Orbiter spacecraft took this photo of the Earth while on its 16th orbit of the Moon.

9

THE VITAL LINK

Where are they now? What's happening? The answers are instantly available across the thousands of miles that separate Apollo spacecraft from the Earth.

The connecting link is a complex network of radio, radar and optical systems, tied together on a common time base and functioning as NASA's Manned Space Flight Network.

The network has stations around the world at ground sites. Additionally, ships and aircraft serve as receiving and transmitting stations, operating to fill the gaps out of range of the land stations.

All the incoming data feeds through a master switching station at NASA's Goddard Space Flight Center and is instantly relayed to Apollo Mission Control Center at the Manned Spacecraft Center.

The link performs two basic jobs. It defines the location of the spacecraft, and it exchanges information with the crew and with the spacecraft.

In the earliest days of space exploration, it was a difficult job just to find the satellite. Now the problem is to pick out the correct one among the thousand different space travelers hurtling along the celestial freeways.

The Manned Space Flight Network is one of three that NASA operates; it sponsors the operation of a fourth. One of these networks primarily tracks and records data from the many unmanned scientific satellites launched by NASA. A second tracks the lunar, planetary and deep space probes and helps the Manned Space Flight Network during Apollo flights. A third is essentially an optical system for the precision tracking of satellites; it is operated by the Smithsonian Astrophysical Observatory.

These networks and their stations are bound together by a single communication system using satellites, undersea cables, land lines and microwave links.

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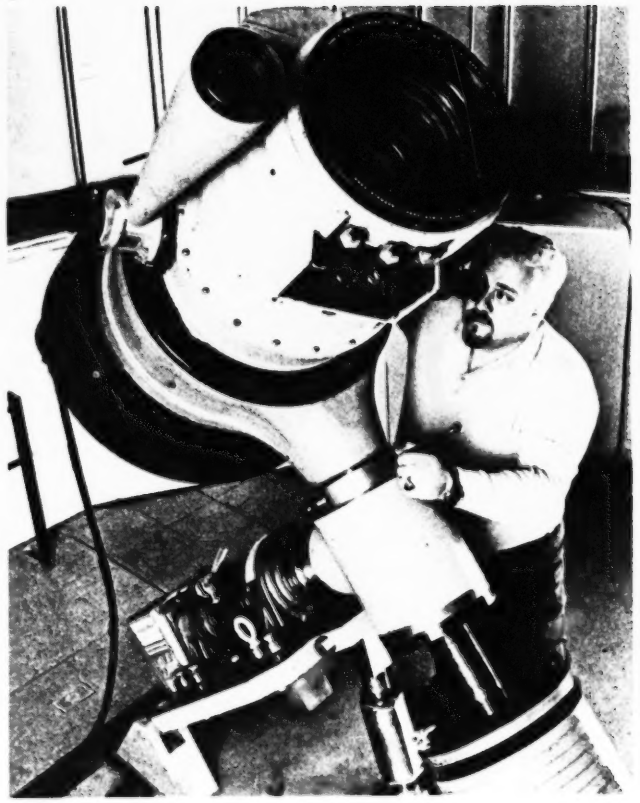

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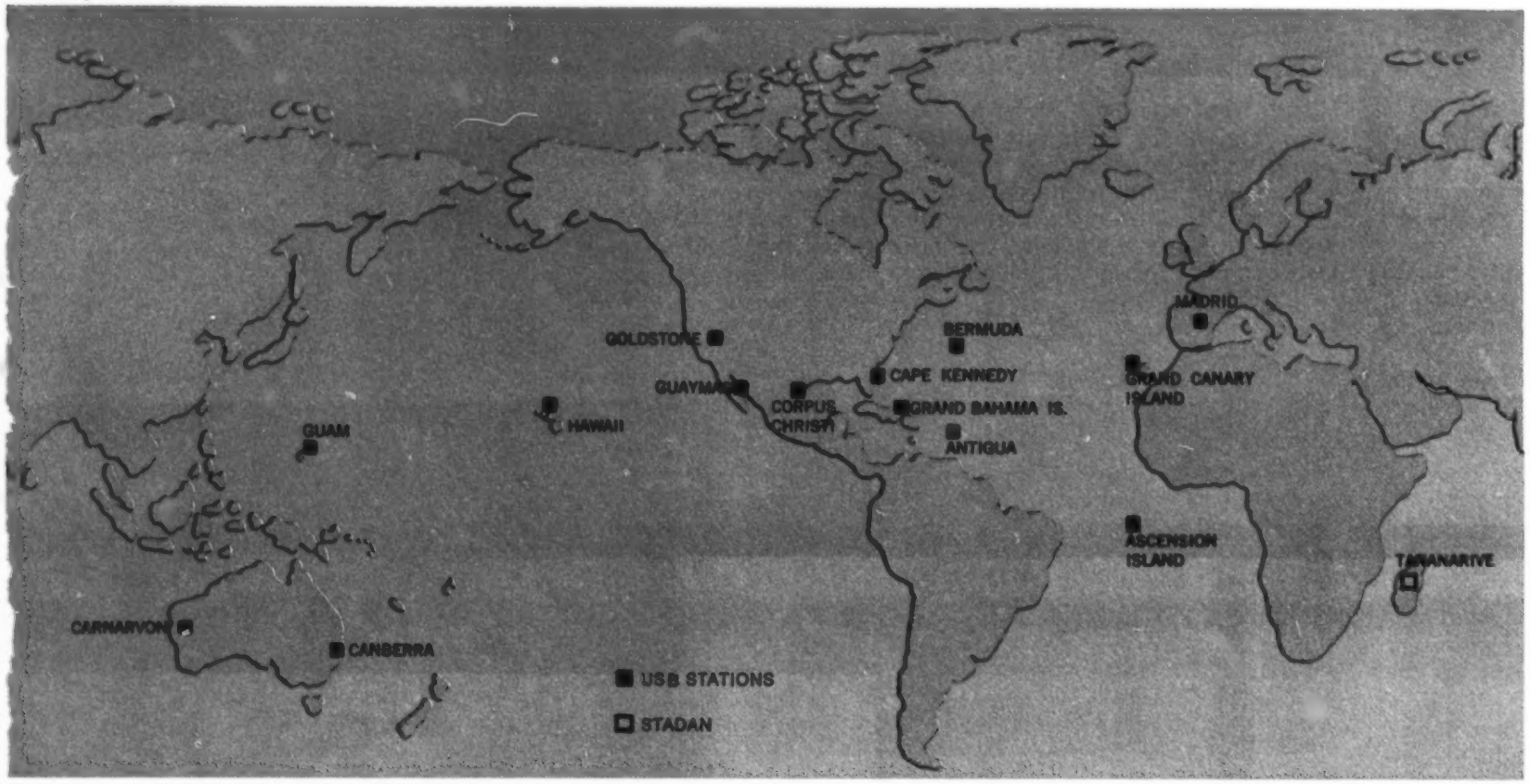

1. Operations Control Center, Manned Space Flight Network at Goddard Space Flight Center. The network keeps in touch with the spacecraft.

2. USNS Redstone is one of four Apollo instrumentation ships that monitor missions beyond the range of land stations.

3. Smithsonian Astrophysical Observatory operates Baker-Nunn cameras for optical tracking of spacecraft.

4. Locations of Manned Space Flight Network.

5. The Goldstone 210-foot diameter antenna used for tracking spacecraft far out in space.

6. Workers inside the 210-foot dish at Goldstone.

7. In the bulbous nose of this four-engine KC-135 are radio antennas that monitor Apollo flights.

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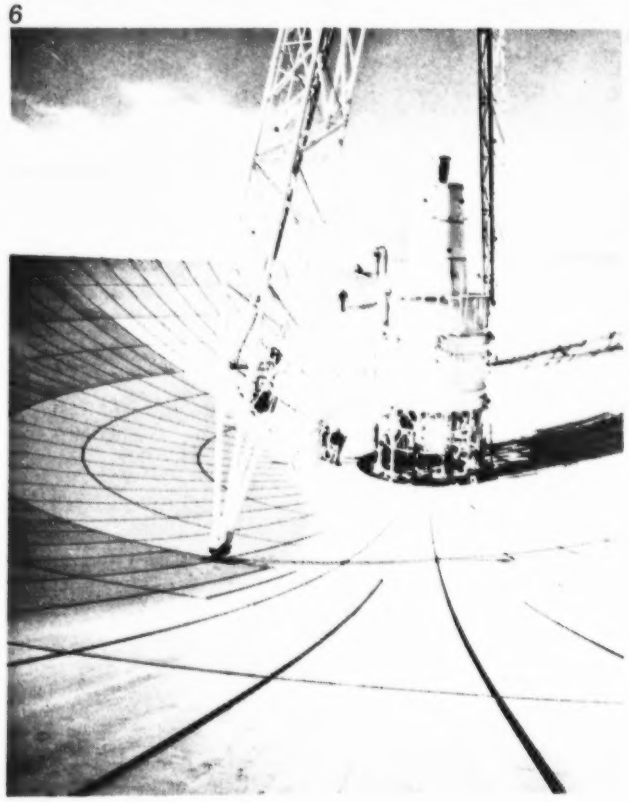

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TESTING: 7...8...9

Astronauts Walter M. Schirra, Jr., Donn F. Eisele and Walter Cunningham rode the Apollo 7 spacecraft into a nearly perfect Earth orbit in the first manned flight of the program. Following a series of unmanned test flights, the Saturn IB launch vehicle lifted the spacecraft off the pad on October 11, 1968.

During the flight they practiced rendezvous and simulated docking with the spent Saturn upper stage. They also beamed back live TV pictures which were transmitted into millions of homes.

Their return to Earth October 22 was within a mile of the predicted splashdown point. The trip had lasted 10 days and 20 hours; they had made 163 circuits of the Earth. The Apollo command/service module and its systems had been proved in a rigorous test.

The Apollo 8 mission will be remembered in history as one of the greatest events of our century. For the first time, men would voyage beyond Earth's gravity, circle the Moon, and return with a priceless cargo of photographs, data and observations.

Astronauts Frank Borman, James A. Lovell, Jr. and William A. Anders set out on their historic voyage of exploration on December 21, 1968.

The curving flight path would take them behind the Moon, out of touch with Earth. There they would fire the rocket engine to nudge them into a lunar orbit.

"One minute to LOS (loss of signal). All systems go. Safe journey, guys." Anders answers for the crew: "Thanks a lot, troops. We'll see you on the other side."

Silence. LOS is complete; there are no voices, no telemetered data, no tracking. Ten minutes pass; the engine should be firing now. Apollo 8 should be in lunar orbit. Twenty minutes drag by; thirty, thirty-five . . .

"Go ahead, Houston. Apollo 8." Lovell's voice comes through loud and clear, confirming lunar orbit.

The technical success of Apollo 8 has been almost eclipsed by the emotional impact of the voyage. The sight of Earthrise beyond the Moon, the sharp contrasts between black sky and grey Moon, the sight of craters, and the look back at Earth moved the astronauts. "There's a beautiful Earth out there," said Borman.

But on Christmas Eve, Borman turned to Genesis for the words, and a hushed world listened while the astronauts read the first verses of the story of creation.

James A. McDivitt, David R. Scott and Russell L. Schweickart, on board, Apollo 9 lifted off the pad at Kennedy Space Center on March 3, 1969.

This flight was an exercise for the lunar module, missing from previous flights, to test the last major part of the Apollo system. Maneuvering, rendezvous and docking were performed in Earth orbit, instead of near the Moon.

Apollo 9 completed the Earth-orbital testing phase of the spacecraft. All the elements had been tested thoroughly. Only one more mission remained before the lunar landing.

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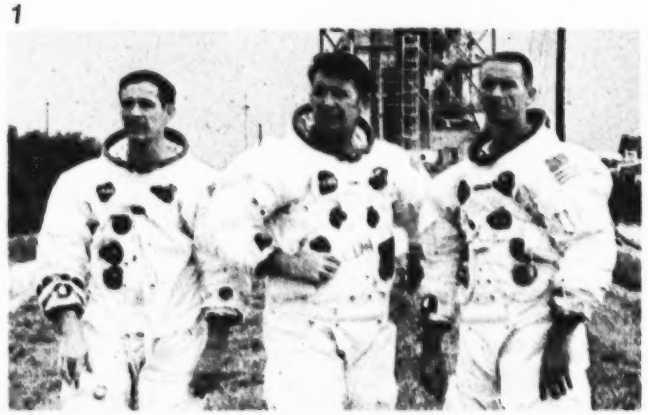

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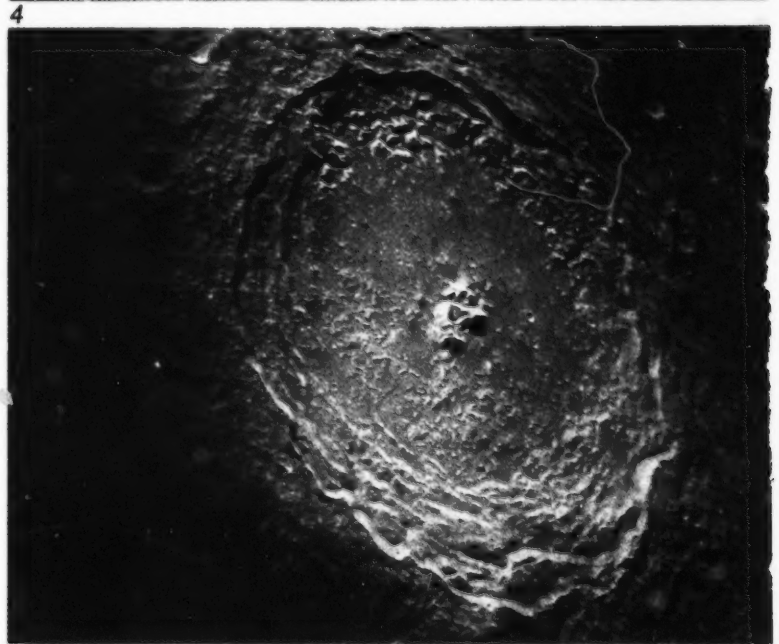

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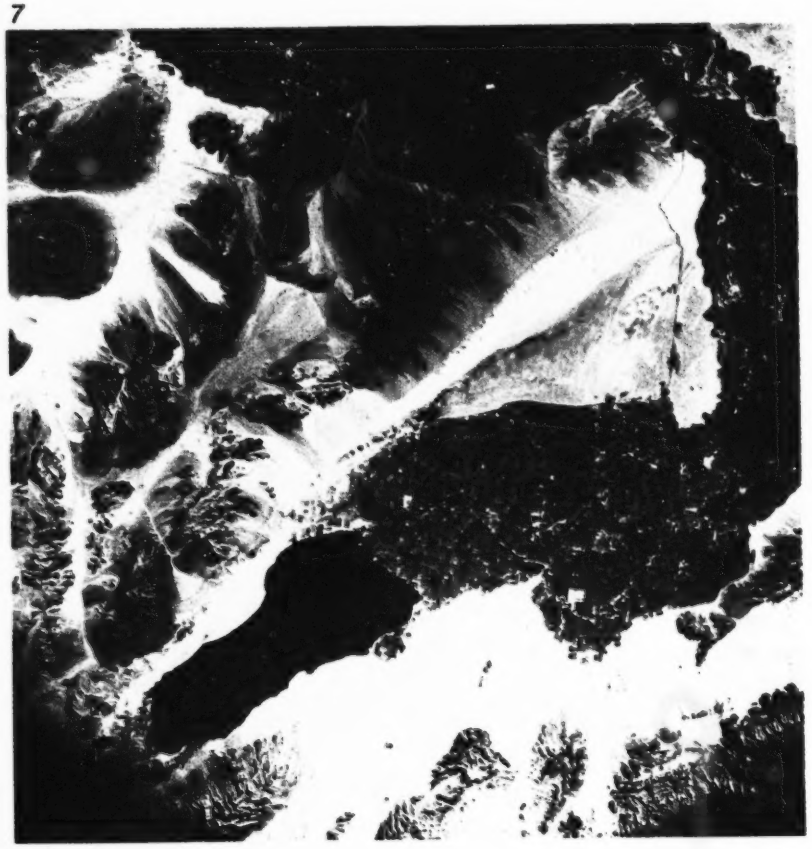

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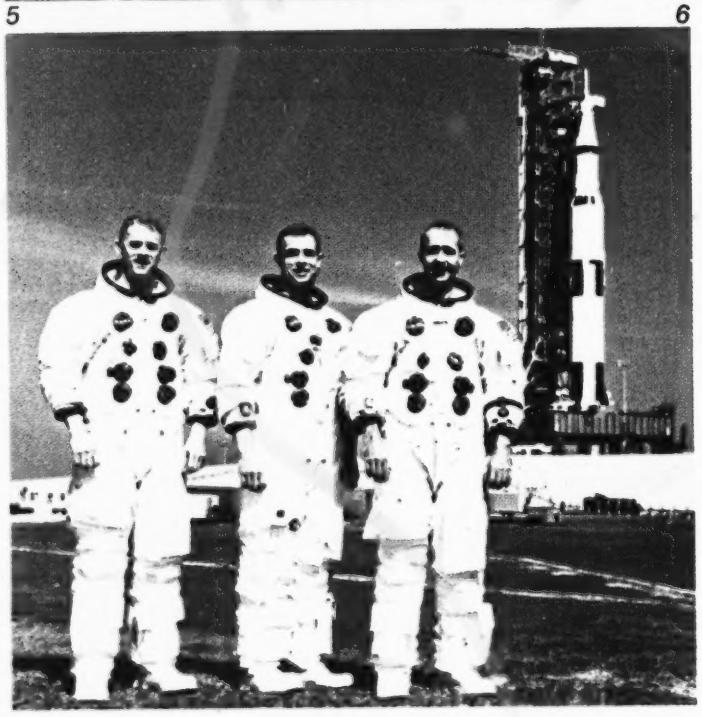

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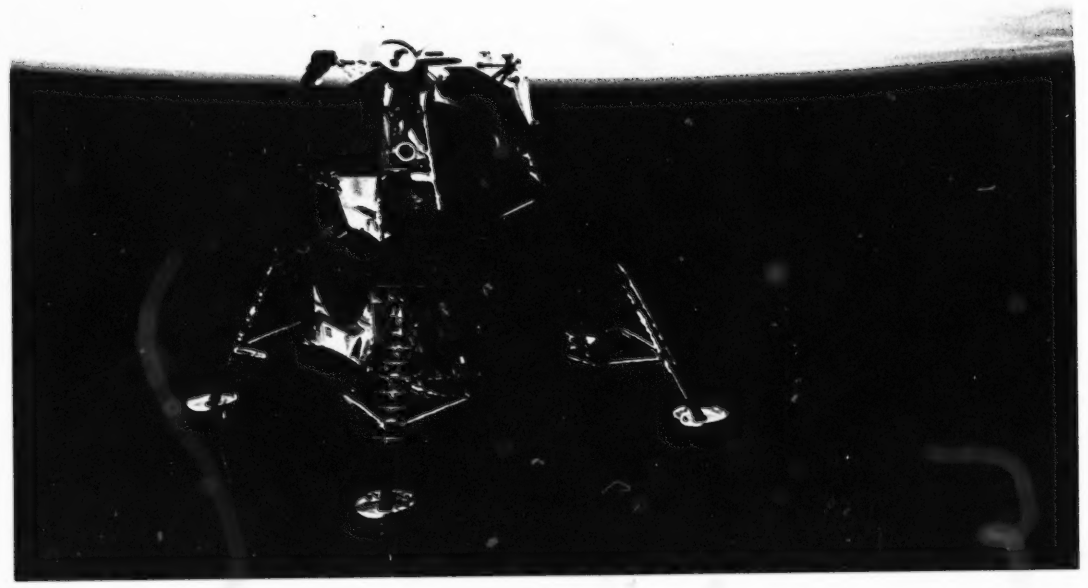


1. (Left to right) Donn F. Eisele, Walter M. Schirra, Jr. and Walter Cunningham—the crew of Apollo 7.

2. Apollo 7's discarded upper stage.

3. (Left to right) Frank Borman, William A. Anders and James A. Lovell, Jr.—the crew of Apollo 8.

4. "Langrenus is quite a huge crater; it's got a central cone to it."—Astronaut Lovell.

5. The Earth is viewed by the Apollo 8 astronauts as they orbit the Mo.

6. (Left to right) Russell L. Schweickart, David R. Scott, and James McDivitt—the crew of Apollo 9.

7. Infrared color photograph taken from Apollo 9 of California's Salton Sea and Imperial Valley.

8. The Apollo 9 lunar module, as seen from the command/service module (CSM).

11

DRESS REHEARSAL

Apollo 10, dress rehearsal for the lunar landing, duplicated every step of the planned Apollo 11 flight but one: The touchdown on and liftoff from the lunar surface. Apollo 10 was planned to go no closer than 50,000 feet.

On May 18, 1969 Apollo 10 rose slowly off the pad and swung out into its eight-day mission. Aboard were astronauts Thomas P. Stafford, John W. Young and Eugene A. Cernan, veterans of earlier Gemini flights.

Within a few hours after liftoff, millions saw the docking of their command module with the lunar module in the first live color television pictures ever sent from space. Soon after, they were able to see Earth as the astronauts saw it, again in color.

Apollo 10 reached and orbited the Moon. Stafford and Cernan crawled into the lunar module, separated from Young in the CSM, and began the letdown toward the scarred surface.

"We're right there. We're right over it!" called Cernan as the LM passed over the landing site for Apollo 11. And then he and Stafford, in excited voices, described and photographed the landmarks like tourists in a new world.

Just before their second low pass over the surface, the LM suddenly gyrated. The astronauts seized manual control, stabilized the space craft and, as planned, jettisoned the descent stage.

Analysis indicates that the problem was caused by a malfunction in the backup guidance system which controlled the LM at that time. The system shifted its control modes unexpectedly causing the LM's erratic behavior. Once free of the descent stage, the astronauts shifted to the primary guidance system control and there were no further difficulties.

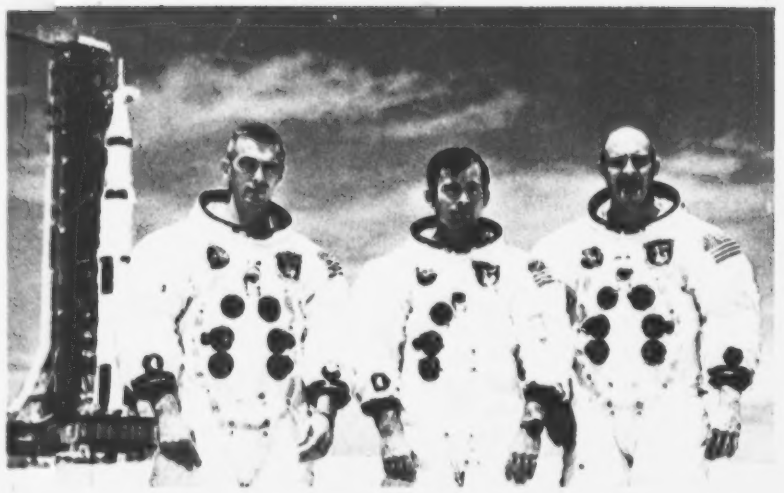
To rendezvous with Young, orbiting overhead in the command and service module, Stafford and Cernan had to fly the ascent stage through exacting and difficult maneuvers.

Rendezvous and docking completed, Stafford and Cernan crawled back into the command module. They jettisoned the ascent stage, its engine was fired and it spun off into solar orbit.

The rest of the time in lunar orbit was spent in landmark sighting, to locate key physical features of the Moon, and in photography of the lunar surface. Continuing color television transmissions brought the awesome starkness of the Moon and the distant beauty of Earth into millions of homes.

And then on the last lunar orbit, behind the bulk of the Moon, the service module engine fired again to start the long return trip.

They splashed down near Samoa, tired, but exhilarated by what they had seen and done. Apollo 10 had blazed the trail almost to the Moon; now all that remained was the lunar landing of Apollo 11.



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1. *(Left to right) Eugene Cernan, John W. Young, Thomas Stafford—the crew of Apollo 10.*
2. *LM moves off for its close look at the lunar surface.*
3. *Command module photographed in lunar orbit by the crew of the lunar module.*
4. *"The Moon is set against the blackest black you ever saw", said Stafford.*
5. *The Earth as photographed by the Apollo 10 crew.*
6. *The ascent stage of the LM returns from its close look at the Moon to find and dock with the CSM.*
7. *"No matter where you look . . . there's a different geologic structure to study", said Cernan.*

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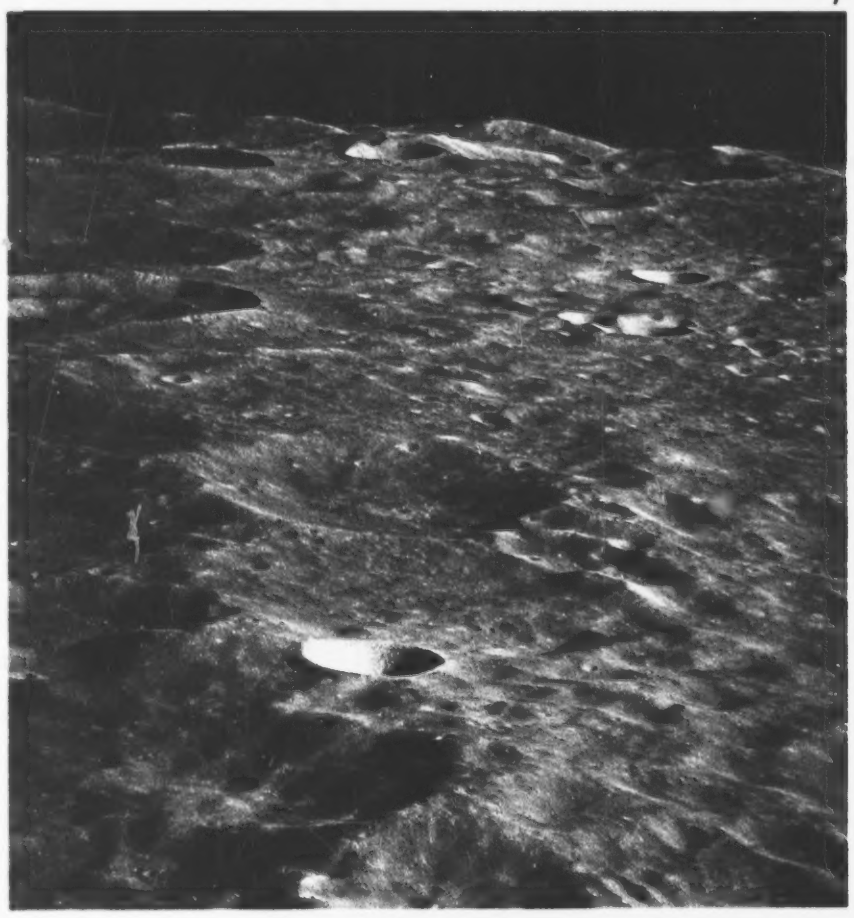


12

TOMORROW IS NOW

And now, Apollo 11; the first landing of man on the Moon. To describe it now, while the phases of the mission are only black words on white paper, is like describing tomorrow's sunrise. It will happen, but how golden will the sky be? How bright the clouds? What color the light of dawn on the trees and the grass?

The words that now define each step of the long voyage outward, the orbital path around the Moon, the descent of the lunar module and the walking of man on the Moon—these words are in the shorthand of technology.

"The LM will be depressurized to allow astronaut egress to the lunar surface. The EVA duration for the first astronaut is open-ended . . . the second astronaut will egress and perform EVA functions."

These precise words, these neat acronyms, remove the emotions that might otherwise cloud the scientific objectivity of this exploration.

It will be a hard day's work, from the moment of touchdown on the Moon until the liftoff of the ascent stage.

"We're planning to spend slightly under 22 hours on the surface. The first thing the guys will do is get ready to launch again . . . in the event of any kind of emergency.

"After that they will eat and have a four-hour rest period. You could call it sleep except that I'm not sure how well any man can sleep in the . . . cramped quarters."

(Could you sleep, knowing that just outside your bedroom door the surface of the Moon waited?)

And then, the rest period over, the exit hatch cracks open, swings wide, and the first astronaut descends the ladder from the old world.

"We have to learn how to walk and jump and move from one place to the other in this environment of one-sixth gravity . . . how to do all the things we've all learned here on Earth from the time we first started to walk."

(If I stumble, will I fall? If I fall, will I be able to get up again?)

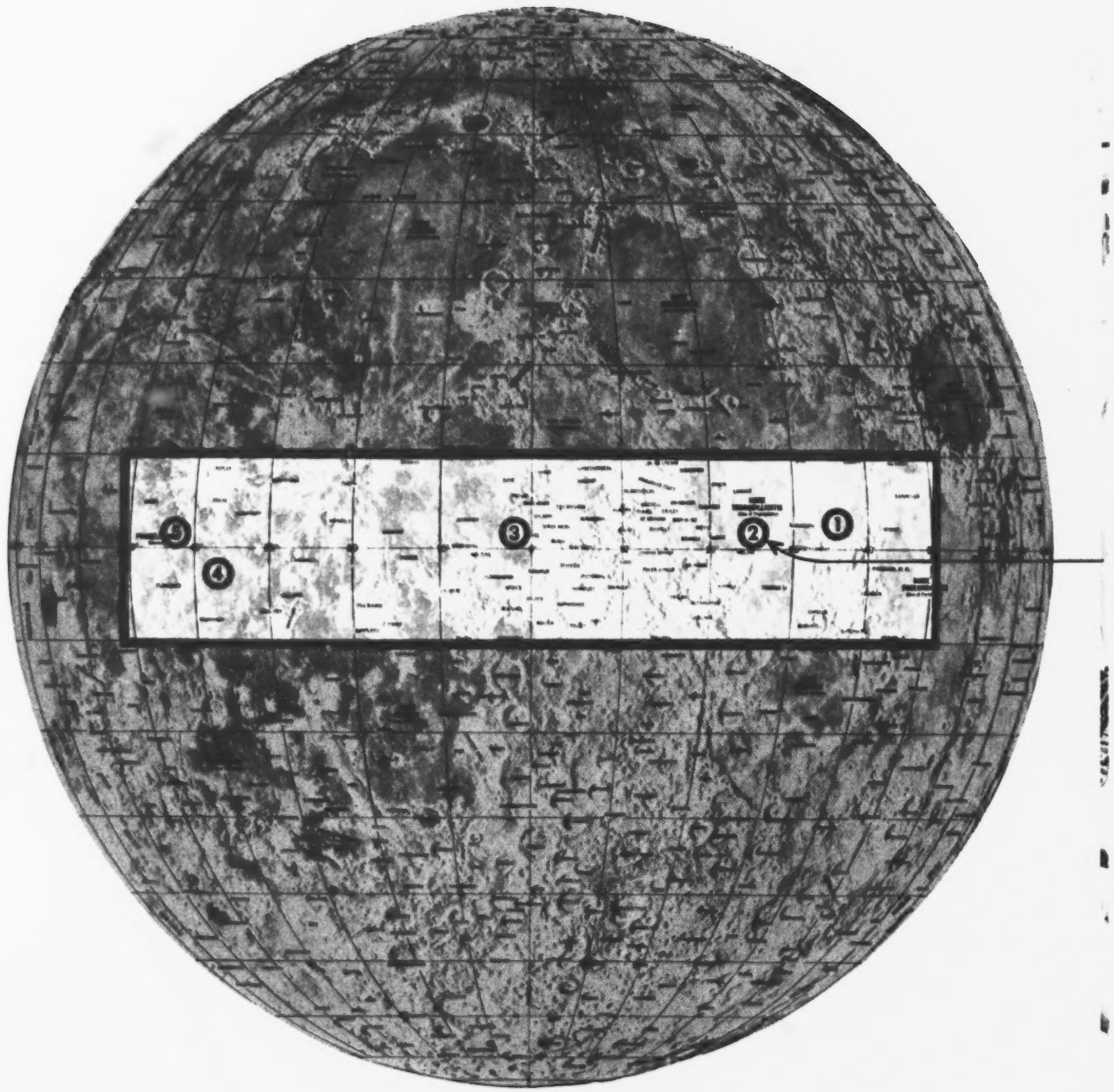
"First and foremost . . . a piece of the Moon, a lunar sample. We will evaluate the capability of astronauts to work in this environment."

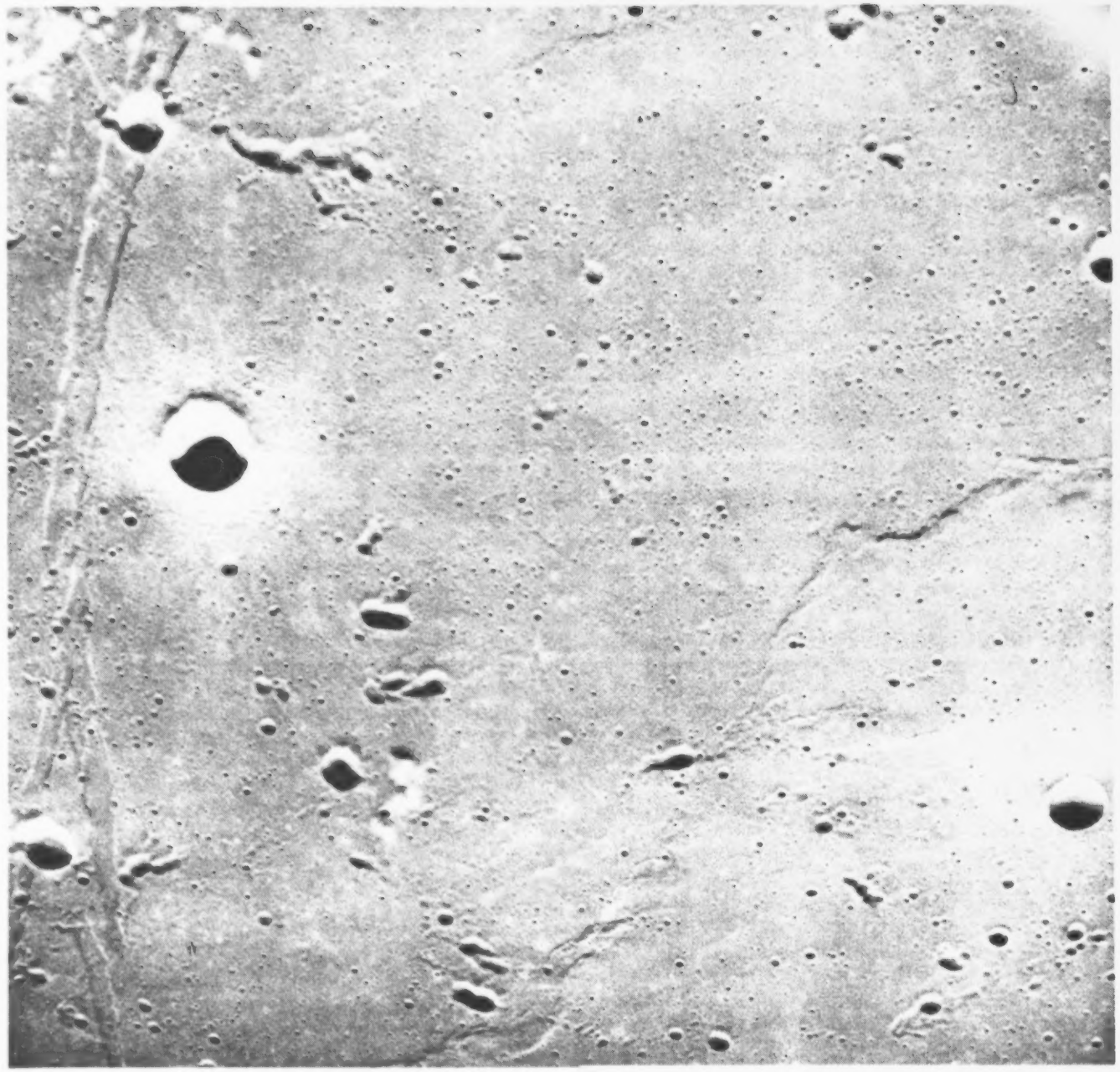
(I have to fight the suit; it's an effort to move my arm, to put one foot in front of the other.)

"The men will then deploy an experiment package . . ." It stays behind, feeling for any tremors of the Moon's mass, monitoring possible seismic activity, possible Moonquakes.

Back inside the lunar module, the two astronauts rest. Four or five hours pass, following the two or three spent on the lunar surface. They fire the ascent module, fly to orbit and rendezvous with the command and service module, and all that remains is the voyage home again.

(That's a beautiful Earth out there!)





Mare Tranquillitatis (Sea of Tranquility), near the lunar equator, has been chosen as the prime landing site for the Apollo 11 lunar landing mission. The site was photographed (on the right) by the crew of Apollo 10.

"All of us involved have the responsibility to consciously strive to make the flight to the Moon not an end in itself, but the spearhead for a whole set of undertakings over the entire front of positive human endeavors, be they in science or the arts, social progress or medicine."—Dr. Martin Schwarzschild, Astronomer, in Congressional testimony, 1963.

13

NOT THREE, BUT THOUSANDS

Astronaut Neil A. Armstrong will be the first man on the Moon. Astronaut Edwin E. Aldrin, Jr., will be the second. The third Apollo 11 crewman will be Astronaut Michael Collins, orbiting miles above the surface in the command and service module.

But the total crew for the Apollo 11 mission numbers in the hundreds of thousands. Secretaries and steelworkers, doctors and draftsmen, technicians and tailors contributed their share of work critical to the success of the mission. Former NASA Administrators T. Keith Glennan and James E. Webb, the present Administrator Thomas O. Paine; the late Dr. Hugh L. Dryden, a gentle and extraordinary scientist; and Robert C. Seamans spearheaded the Nation's effort to explore space.

Astronauts Armstrong, Aldrin and Collins are the prime crew for Apollo 11. Armstrong will command the mission; Aldrin will be the pilot of the lunar module, and Collins will be the command module pilot.

The backup crew—on standby in case even one of the prime crew members could not go—will be Astronauts James A. Lovell, commander; William A. Anders, command module pilot; and Fred W. Haise, Jr., lunar module pilot.

Each of the prime crew has completed a Gemini mission, and each had been named as a backup crew member on other Gemini missions.

Armstrong had been a pilot in NASA's X-15 research aircraft program, a Naval aviator and had flown combat missions in the Korean conflict. He has a degree in aeronautical engineering and was named an astronaut in 1962.

Aldrin also had flown in combat over Korea, but as an Air Force officer. He graduated from the U. S. Military Academy and holds a doctor of science degree in astronautics. He was chosen as an astronaut in 1963.

Collins had been doing experimental flight tests as an Air Force officer when he was selected as an astronaut in 1963. Like Aldrin, he graduated from the U. S. Military Academy, and has a bachelor of science degree.

Collins and Aldrin are among the few astronauts who have "walked" and worked outside their spacecraft. Aldrin spent more than 5½ hours outside the Gemini 12, and Collins worked outside the Gemini 10 on three separate operations.

The experience and skills of these three highly trained astronauts now are concentrated on the goal of the Apollo 11 mission.

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1. Inside the lunar module simulator during a training session.

2. Edwin E. Aldrin, Jr., Lunar Module Pilot.

3. Neil A. Armstrong, Commander.

4. Michael Collins, Command Module Pilot.

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14

THE VOYAGE OUT

The Apollo 11 spacecraft has been mounted atop the Saturn V launch vehicle, and sits on the pad ready for launch.

Through the days of the countdown, each system has been checked, each test performed, each safety measure verified.

Now Astronauts Armstrong, Aldrin and Collins are seated inside the command module and the final countdown has begun.

"We have ignition . . ." The Saturn V's rockets blast out tongues of flame; poised on the pillar of fire, the huge assembly inches upward. "Tower cleared!" Free of the last touch of Earth, the Apollo 11 mission is on its way.

On course, to the Moon, Collins separates the CSM, turns it in space, docks with the LM and plucks it from the spent S-IVB stage.

Now Apollo 11 nears the Moon, and the familiar drama begins. Behind the Moon they fire the rocket engine to establish lunar orbit, an ellipse that comes within 69 miles of the surface and swings away to a 195-mile distance. They will make two turns around the Moon this way, while they check the spacecraft systems and update the navigation data. Another burst from the service module engine, and the orbit changes to circular, 69 miles from the Moon. The astronauts settle down for an eight-hour period of rest and meals.

Rested and fed, Armstrong and Aldrin squeeze through the connecting tunnel, enter the lunar module, and press their feet to grip the Velcro-mesh flooring with their Velcro-soled shoes. They flick on lights and instruments, check the 160 circuit breakers and the multiple controls. Then they fire the descent rocket to thrust them into an orbit that will take them to a minimum distance of 50,000 feet above the Moon.

Up to this point, Apollo 10 had rehearsed the mission, proved each operation. From here on, even though this part of the flight has been simulated time and time again, the Apollo 11 astronauts are truly on their own.

Now Armstrong, standing on the left, moves his left hand on the throttle of the descent engine. It fires; the lunar module slows into the first leg of the descent. Aldrin's voice calls out key readings from the maze of dials before him; Armstrong watches out of the triangular window at his position.

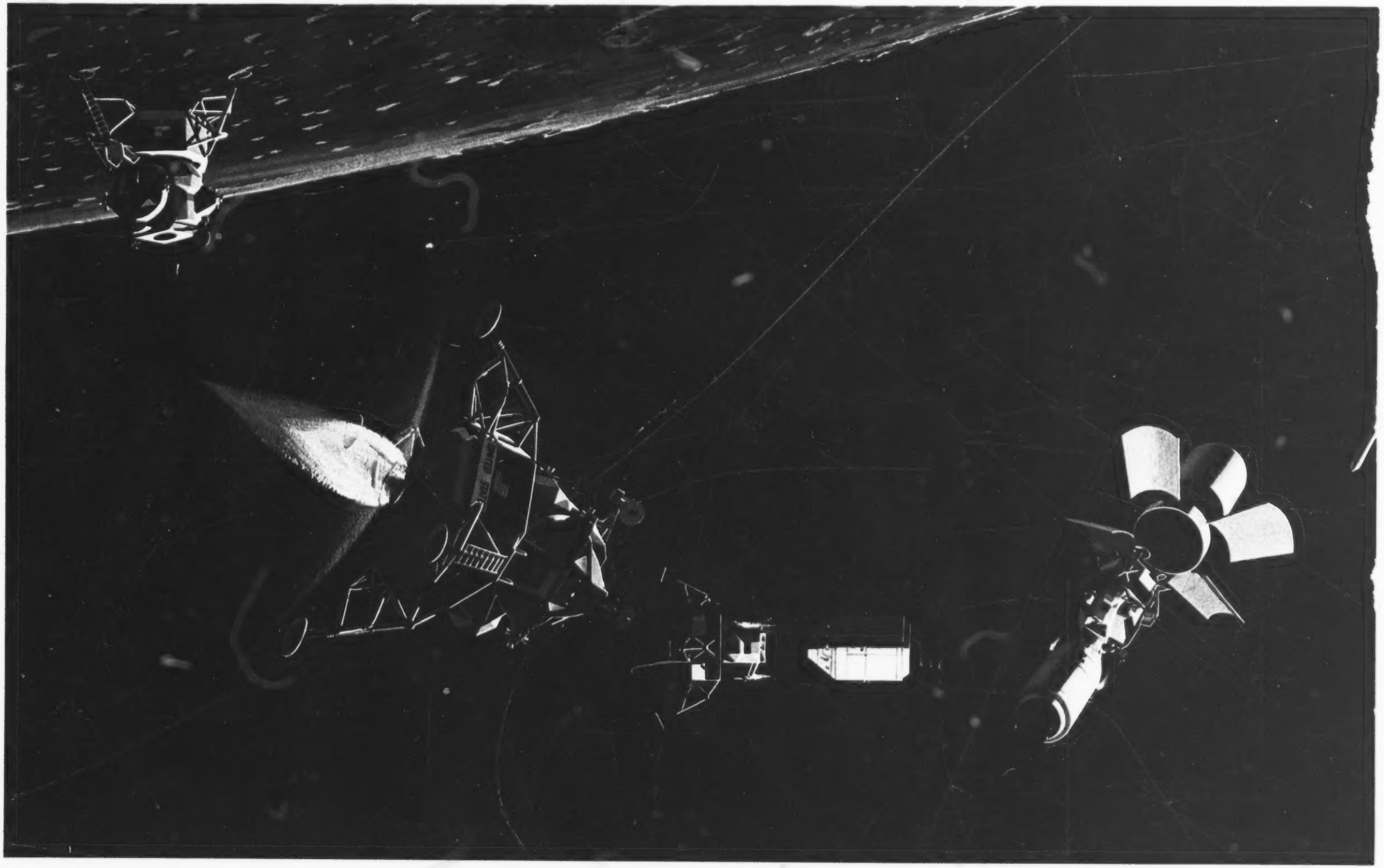
At 9,000 feet the module pitches to give the astronauts a better look at the lunar surface. Armstrong spots the landing site, lines it up with the scribed scales on his window, makes a slight correction with his hand control.

The height drops . . . 5,000 feet . . . 3,000 feet . . . 1,000 feet. Armstrong changes the throttle through the descent, slowly reducing the approach speed. At 500 feet altitude the lunar module is dropping lightly at three feet per second.

And now the engine thrusts harder, slowing the descent even more. The landing probes, mounted on the spindly legs of the lunar module, seem to strain toward the Moon. They touch; a warning light flashes in the cockpit, and Armstrong's left hand cuts the engine. There is a slight jar.

Both astronauts release their pent-up breath, held for those last few seconds. They stare out the windows at the lunar surface on which their spacecraft now stands.

The voyagers have landed on a new world.



15

MAN EXPLORES THE MOON

As Commander of the Apollo 11 mission, Armstrong goes first. He depressurizes the lunar module, opens the hatch, makes his final decision and steps out on the "front porch," a small platform above the ladder. He checks his communications, talking to Aldrin, then turns around to start backward down the ladder.

Nine steps down on its rungs, the tenth step on the foot-pad—and the eleventh step is the Moon itself. He feels the surface under his feet, stands upright, turns, and sees the awesome lunar panorama.

In the long cold shadows, it is about 200 degrees below zero; in the open, it is more than 200 degrees above. His landing site is ringed with mountains, the walls of the craters that dot the Moon. It is a barren land, nearly colorless land, black in the shadows, almost white in the light, with only a range of grays and browns to give shape and definition.

He rests for a few minutes, checks his suit, its equipment and the back-pack life support system. He starts to walk, straining against the nearly rigid space suit.

Each step Armstrong takes, each activity he performs, has been planned to build the workload gradually. At each level of activity, medical and scientific data is being taken, monitoring his ability to survive, to move and to work in the relentless environment of the Moon.

He starts with a simple walk near the lunar module, feeling strangely heavy on his feet even though the Moon's low gravity has reduced his normal 165 pound weight to 27½ pounds, and the weights of the suit and back-pack in the same proportions.

With bags on an extendible handle, Armstrong scoops up the first sample of lunar soil. Again there is a period for checks of equipment, surface lighting and other characteristics. Aldrin lowers a camera to Armstrong, makes his final check before calling to Collins, orbiting in the command module, that he is going out to join Armstrong. He backs down the ladder, photographed by Armstrong and rests at the bottom.

More than 40 minutes have passed; now Armstrong mounts the TV camera on its tripod, pans around the horizon and positions it to monitor their activities. Aldrin, now familiarized with the strange sensations of Moon walking, unwraps the solar wind experimental package.

Devised by a Swiss scientist, this one-pound experiment uses an unrolled sheet of aluminum foil to entrap particles of helium, neon, argon, krypton and xenon moved by the "solar wind."

Aldrin photographs Armstrong collecting bulk samples of the Moon. Both astronauts inspect the lunar module, photograph it and the lunar panorama. Aldrin opens a storage bay in the lunar module, takes out the remaining two surface experiments. One is a complete seismic station, linked to Earth stations by internal radio. Powered by solar cells, it is expected to operate for about a year, feeling for and transmitting data on seismic disturbance of the lunar mass.

The other experiment is a group of precisely built optical reflectors to bounce back laser beams from Earth. It will help measure the distance between Earth and Moon more precisely, determine the Earth's rotational rate, and check scientists' theories of intercontinental drifts.

Both experiments should take about 15 minutes to emplace; the rest of the available time on the surface is spent collecting lunar samples and documenting the collection with photography. They stay within a 300-foot radius of the lunar module, the limits of exploration set for this trip.

Aldrin re-enters the lunar module first while Armstrong retrieves the solar wind experiment and follows up the ladder. Total time outside on the Moon—two hours and 20 minutes for Armstrong; one hour and 35 minutes for Aldrin. Now they eat and rest in preparation for another critical phase of the mission—the ascent and rendezvous with Collins.

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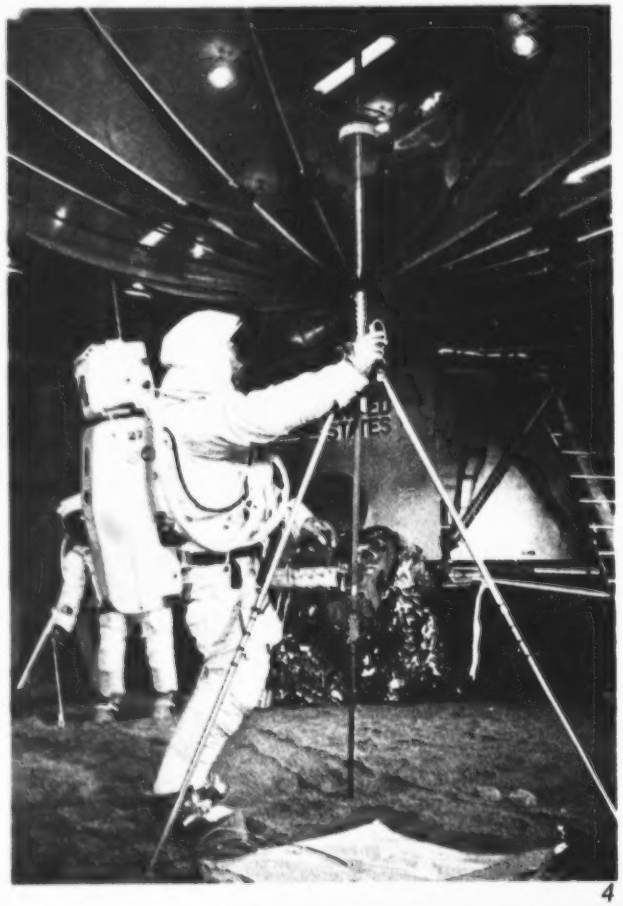

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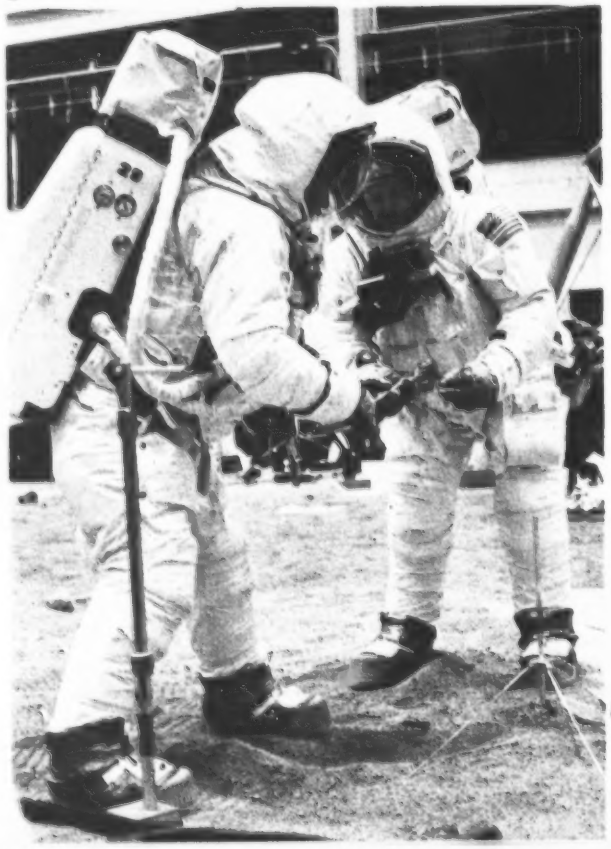

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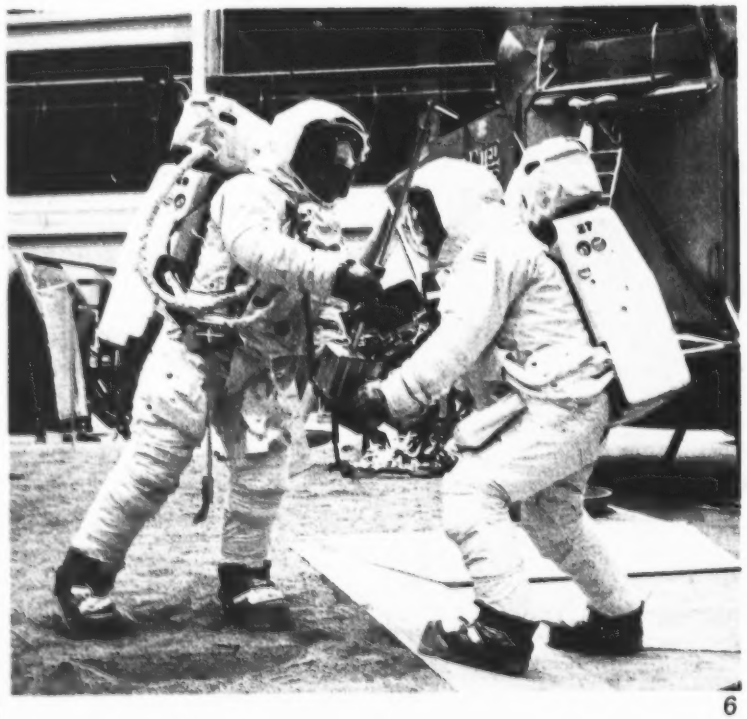

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1. Taking pictures during practice lunar surface activities at Manned Spacecraft Center, Houston.

2. Removing equipment from lunar module mock-up . . .

3, 4. Erecting an umbrella antenna . . .

5. Collecting rocks with special claw . . .

6. Collecting of more samples . . .

". . . any nation, to remain great, must lead in exploration of the unknown and the discovery of new worlds." Richard M. Nixon, 1968.

16

". . . AND RETURNING HIM SAFELY . . ."

About 22 hours after they touched down on the Moon, the astronauts prepare to leave. Again, things must work perfectly the first time. The ascent engine has lain dormant through the entire voyage; now it must fire. The astronauts check the instruments and controls and the start cycle begins. On a signal from the LM's guidance computer the ascent stage fires and lifts-off from the descent stage. They feel the force of acceleration in their legs as the ascent stage climbs to a rendezvous with Collins and the command module.

Armstrong and Aldrin use every bit of their piloting skills to ease the lunar module ascent stage into orbit with the command and service module.

Using the spacecraft control rockets, Armstrong and Aldrin fly the rendezvous; Collins works with them, as the spacecraft drift slowly toward docking. There is a slight bump as probe and target meet. The latches slap shut. They have rejoined.

The Astronauts crawl through the tunnel back to the command module, carrying the precious samples of the Moon, the solar wind experiment, and exposed film.

Now they jettison the lunar module; they coast in lunar orbit, sighting, calculating and updating for navigational data. Three and one half hours pass, and then, again behind the Moon and out of sight of Earth, they fire the service module engine. It thrusts them out of lunar orbit and onto the road home.

All the way back, communications links reach across the miles and exchange information, observations, commands and conversations.

What remains is re-entry, the terminal maneuvers of every manned space flight. Six Mercury flights, ten Gemini flights and four Apollo missions have rammed into the Earth's atmosphere before them. But no matter how much experience is available, how many rehearsals, each re-entry is new. The exact angle is critical; too shallow, and the spacecraft caroms off into space like a skipping stone over water; too steep, and the heat of re-entry builds too rapidly for survival.

Apollo 11 slides through the entry corridor as if on rails, slams into the atmosphere at 400,000 feet up, and starts to glow eerily with frictional heat. The blistering ionized gases pull a blackout curtain over communications, and again the ground stations wait tensely for radio chatter to start.

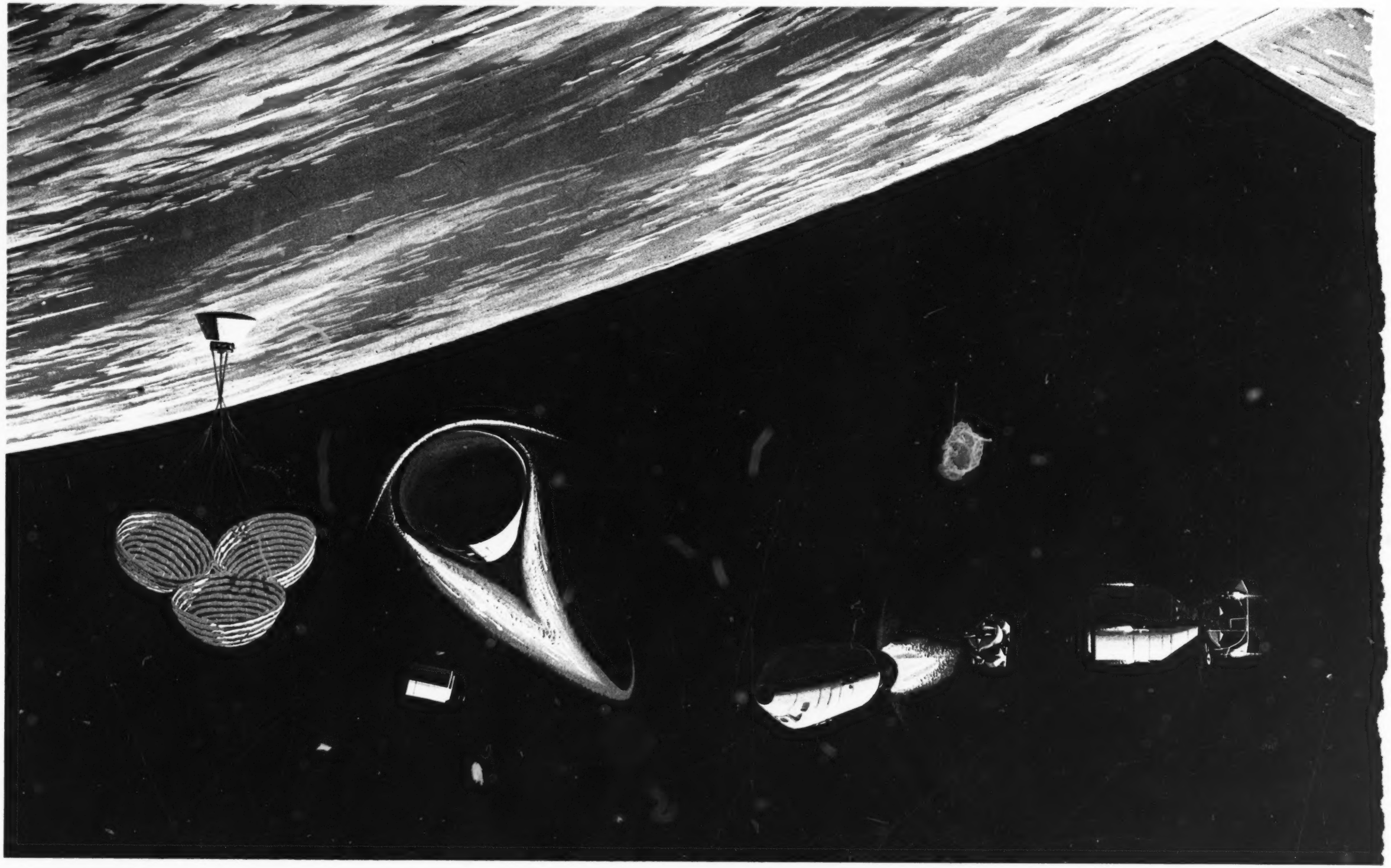
The seconds tick past; the radio comes to life. Now the drogue parachutes burst out of their container to slow the falling spacecraft. They are jettisoned, and three reefed main parachutes stream out. With a sudden jerk, the chutes spread to their full diameter and the spacecraft starts its final cushioned drop into the Pacific Ocean.

The longest part of the trip is to come. To the Moon and back took about eight days; but to the Lunar Receiving Laboratory and out will take about three weeks.

There is a possibility—a remote one—that contaminants may be brought back from the Moon. To be safe, the crew, spacecraft and attending medical specialists will go into immediate quarantine as soon as possible after the splashdown.

The first frogman to reach the floating spacecraft will hand in plastic suits, coveralls with breathing masks for the astronauts. Recovered by helicopter, the astronauts will go immediately into a mobile quarantine van, joining a flight surgeon and a recovery technician.

After the recovery carrier has docked, the van will be trundled into the belly of a cargo aircraft—and flown to the Lunar Receiving Laboratory at NASA's Manned Spacecraft Center. The lunar samples will be flown by relays of fast jet aircraft from the carrier to land bases and then to the lab.



17

PRECIOUS CARGO

The world's most precious stones—about 50 pounds of Moon—will be the focus of post-flight scientific studies. The Lunar Receiving Laboratory (LRL) at Houston is the first stop for these priceless specimens.

Planned and built like the communicable disease wing of a hospital, but to even more exacting standards, the LRL places its work areas behind biological barriers. No organism can escape through air, water or sewer systems to the outside.

Here the astronauts will stay in quarantine, under careful medical observation, until 21 days have passed from the time they lifted off the lunar surface.

The spacecraft itself, sterilized by the heat of re-entry, will be transported to the LRL for quarantine.

The lunar samples will stay in the lab under quarantine conditions for 45 to 60 days. Transported in two separate boxes and two separate aircraft, the lunar samples arrive at LRL. Each box was vacuum sealed on the Moon, and the first probing of their contents is to check that vacuum. A gas analysis system is tapped into each box, in vacuum, to sniff the composition of any gases inside.

Then the boxes are opened, still in vacuum conditions, under the eager eyes of geo-scientists. Samples will be photographed from six sides as they rest in the vacuum chamber, and then tested for radioactivity and biological organisms.

Then the samples will be divided into portions to be allocated to 140 scientists here and abroad who have devised special research to look at the structure, physical, chemical and possible biological characteristics of the Moon.

Some of that work will be done at LRL, because of the convenience; other work will be done at laboratories and universities around the world.

Only a part of the total sample will be distributed in this first round of experiments. The scientists at LRL reason that you always think of the best experiment just after you have run out of subject, and they are determined not to let that happen with their precious pieces of Moon. They will store some for later experimentation.

A smaller portion will be kept away from all experimenters, to be preserved for posterity. In years to come, still-Earthbound people may be able to see, sealed in a vacuum container and placed on public view, those rare gray rocks that men left Earth to find.

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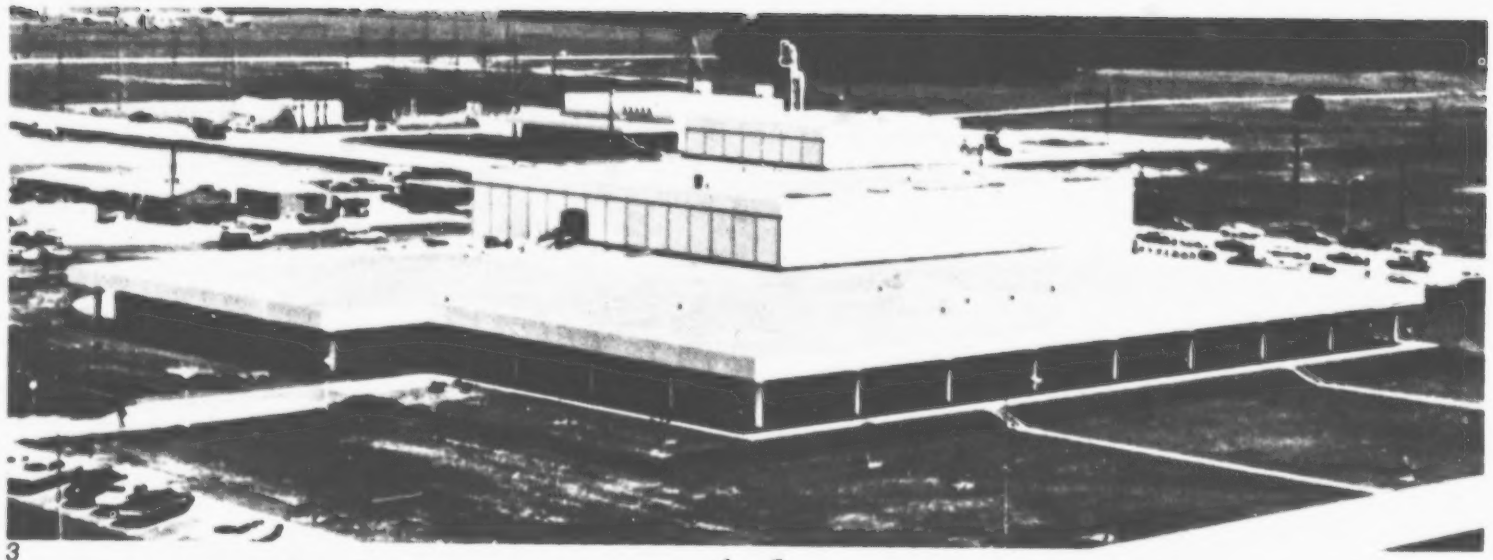

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1. A Biological Isolation Garment (BIG) which will be donned by the Apollo 11 astronauts immediately after egress from the command module, during recovery.

2. A Mobile Quarantine Facility (MQF) for returning lunar astronauts and their support personnel.

3. The Lunar Receiving Laboratory, Manned Spacecraft Center, Houston, Texas.

4. Technician handles materials at the Lunar Receiving Laboratory.

5. Living test animals in the Lunar Receiving Laboratory are observed under germ-free conditions.

18

EXTENDING THE DOMAIN

Nine more manned lunar explorations will follow Apollo 11. These flights will carry a variety of scientific experiments to different areas of the Moon.

The Apollo Applications Program will put an orbital workshop 200 miles away from Earth. It will utilize a spent Saturn upper stage. But it will have additional equipment built in to convert it to a work area and living quarters for its astronaut crews.

It will be about the size of a two-story house, and inside the astronauts will be able to live and move without the cumbersome space suits. They will stay in the workshop for 28 days, and then return to Earth, to be succeeded by another crew. Later missions will extend the stay time to 56 days, and will include a wide variety of experiments. One of these will use a modified lunar module ascent stage to carry an astronomical telescope to the workshop for solar observations free of the Earth's atmospheric distortion.

NASA is studying plans to establish an Earth-orbiting space station, launched and assembled in sections, with a twelve-man crew in the initial element. By the mid 1980's it could be a permanent station, wheeling in the silence of space, manned by as many as 100 astronauts and scientists.

Part of the program would be the development of a space shuttle, a spacecraft about the size of the Douglas DC-3 that pioneered commercial air transport. They would carry about 25,000 pounds of cargo or people, and would make regular runs between Earth and the orbiting base.

New unmanned missions to other planets now are nearing their flight dates. Two Mars probes are on their way to pass near the surface of that planet this summer. Two years from now, two orbiters will close toward the surface for mapping Mars. In 1973, two instrumented spacecraft will touch down in soft landings on the red planet, and a probe will reach to Jupiter for the first direct measurements of that huge planet.

And then in 1977, there comes a rare opportunity, when the planets are positioned just so in the solar system. A single unmanned probe then can be launched for a "grand tour," a flight lasting for years, and passing by Jupiter, Saturn, Uranus and Neptune on a wide swing through our solar system.

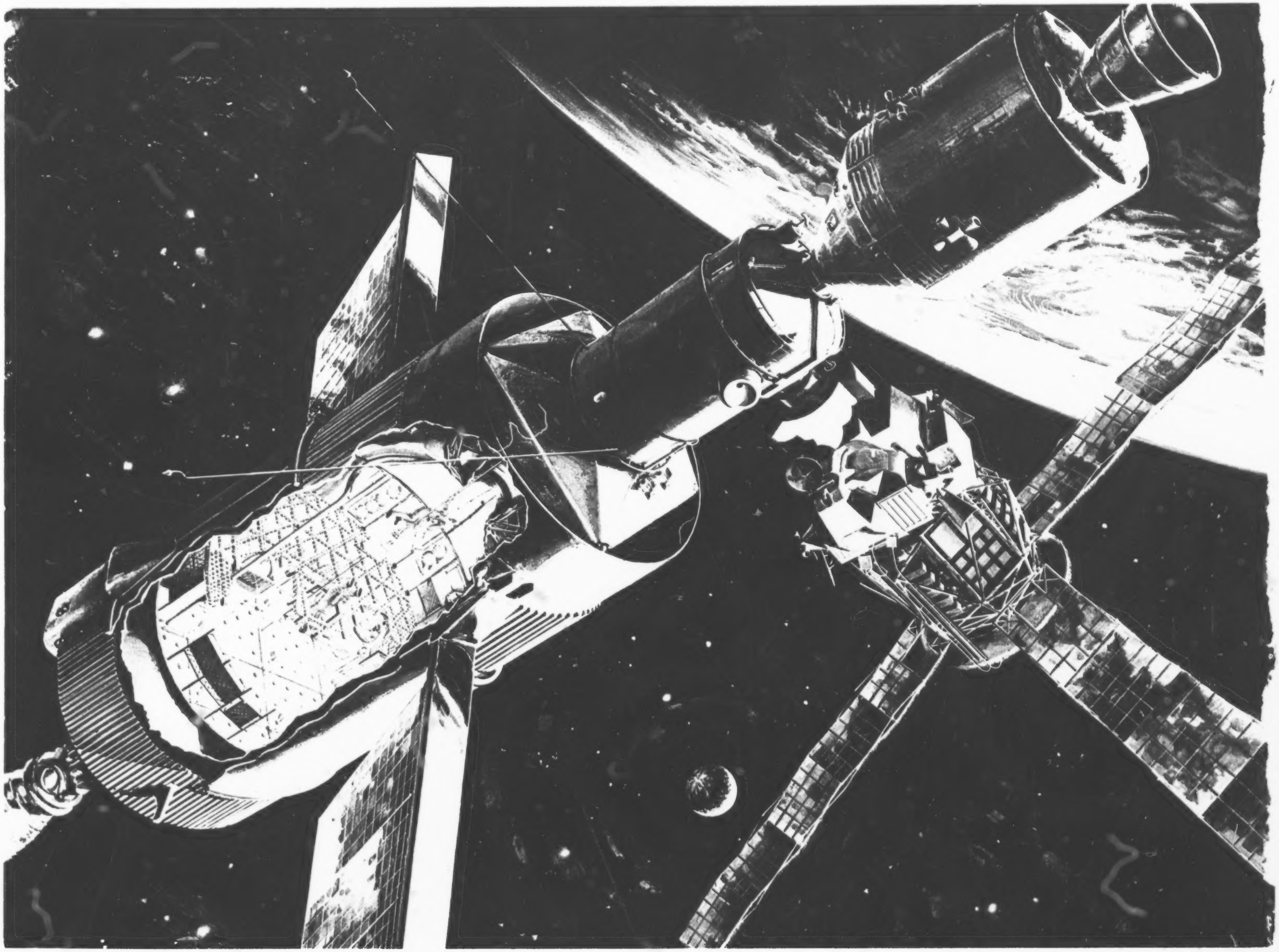
In the 1980's the first manned expedition could be setting off on the voyage to Mars.

For Man always has reached out toward the stars. The first tiny satellites grew to manned spacecraft, to lunar landers, and can grow further to orbiting stations, planetary probes, and expeditions through the solar system.

Speaking to a Joint Session of Congress in January, Astronaut Frank Borman said it this way: "Exploration really is the essence of the human spirit, and to pause, to falter, to turn our back on the quest for knowledge, is to perish."

"We are living at a time when life on Earth is going through this enormous new phase of evolution, when Man is moving from the surface of this planet out into the solar system; many people feel this is as significant as when the first amphibian came from the sea up onto the land and began to conquer a new domain for life."—
Thomas O. Paine, Administrator, NASA, 1969.

Saturn / Apollo Workshop.



APOLLO PROGRAM MANAGEMENT

The Apollo Program, the United States' effort to land men on the Moon and return them safely to Earth before 1970, is the responsibility of the Office of Manned Space Flight (OMSF), National Aeronautics and Space Administration, Washington, D.C. Dr. George E. Mueller is Associate Administrator for Manned Space Flight.

NASA Manned Spacecraft Center (MSC), Houston, is responsible for development of the Apollo Spacecraft, flight crew training and flight control. Dr. Robert R. Gilruth is Center Director.

NASA Marshall Space Flight Center (MSFC), Huntsville, Ala., is responsible for development of the Saturn launch vehicles. Dr. Wernher von Braun is Center Director.

NASA John F. Kennedy Space Center (KSC), Fla., is responsible for Apollo/Saturn launch operations. Dr. Kurt H. Debus is Center Director.

NASA Goddard Space Flight Center (GSFC), Greenbelt, Md., manages the Manned Space Flight Network under the direction of the NASA Office of Tracking and Data Acquisition (OTDA). Gerald M. Truszynski is Associate Administrator for Tracking and Data Acquisition. Dr. John F. Clark is Director of GSFC.

Apollo/Saturn Officials

NASA Headquarters

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Apollo Program Director, OMSF

George H. Hage
Apollo Program Deputy Director, Mission Director, OMSF

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Launch Operations Manager

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Henry F. Thompson
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H. William Wood
Chief, Manned Flight Operations Div.

Tecwyn Roberts
Chief, Manned Flight Engineering Div.

Department of Defense

Maj. Gen. Vincent G. Huston (USAF)
DOD Manager of Manned Space Flight Support Operations

Maj. Gen. David M. Jones (USAF)
Deputy DOD Manager of Manned Space Flight Support Operations, Commander of USAF Eastern Test Range

Rear Adm. F. E. Bakutis (USN)
Commander of Combined Task Force 130, Pacific Recovery Area

Rear Adm. P. S. McManus (USN)
Commander of Combined Task Force 140, Atlantic Recovery Area

Col. Royce G. Olson (USAF)
Director of DOD Manned Space Flight Office

Brig. Gen. Allison C. Brooks (USAF)
Commander Aerospace Rescue and Recovery Service

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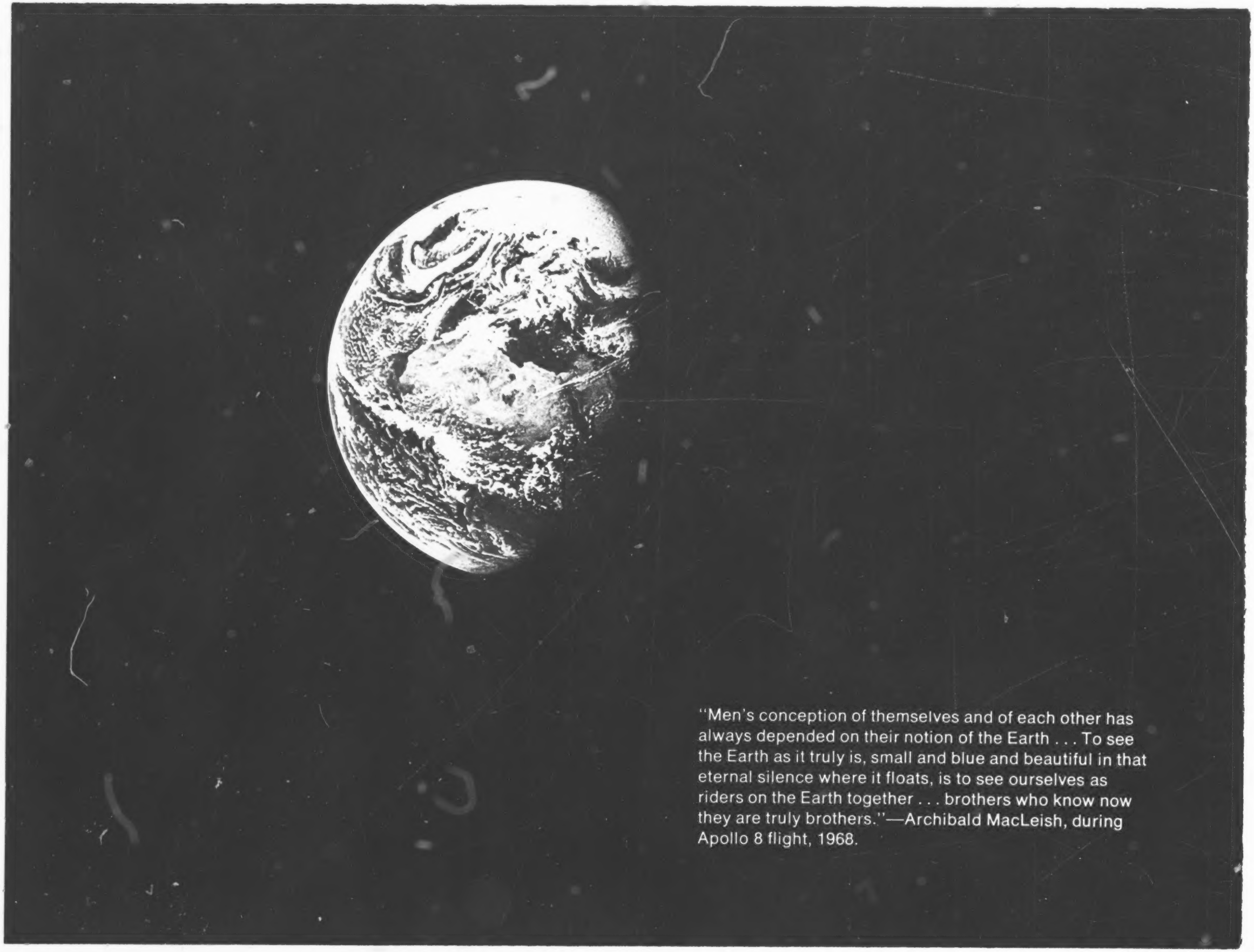
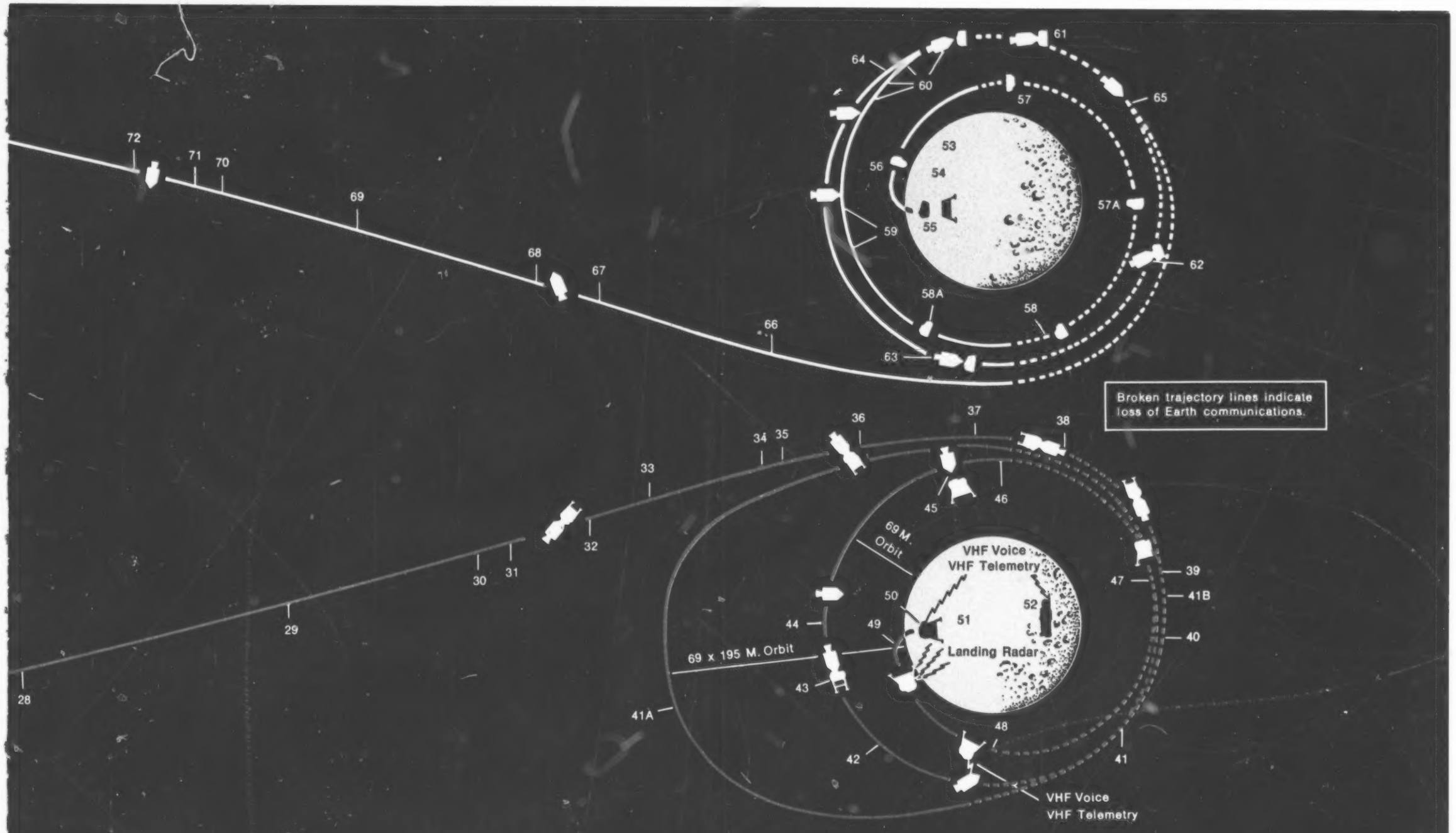
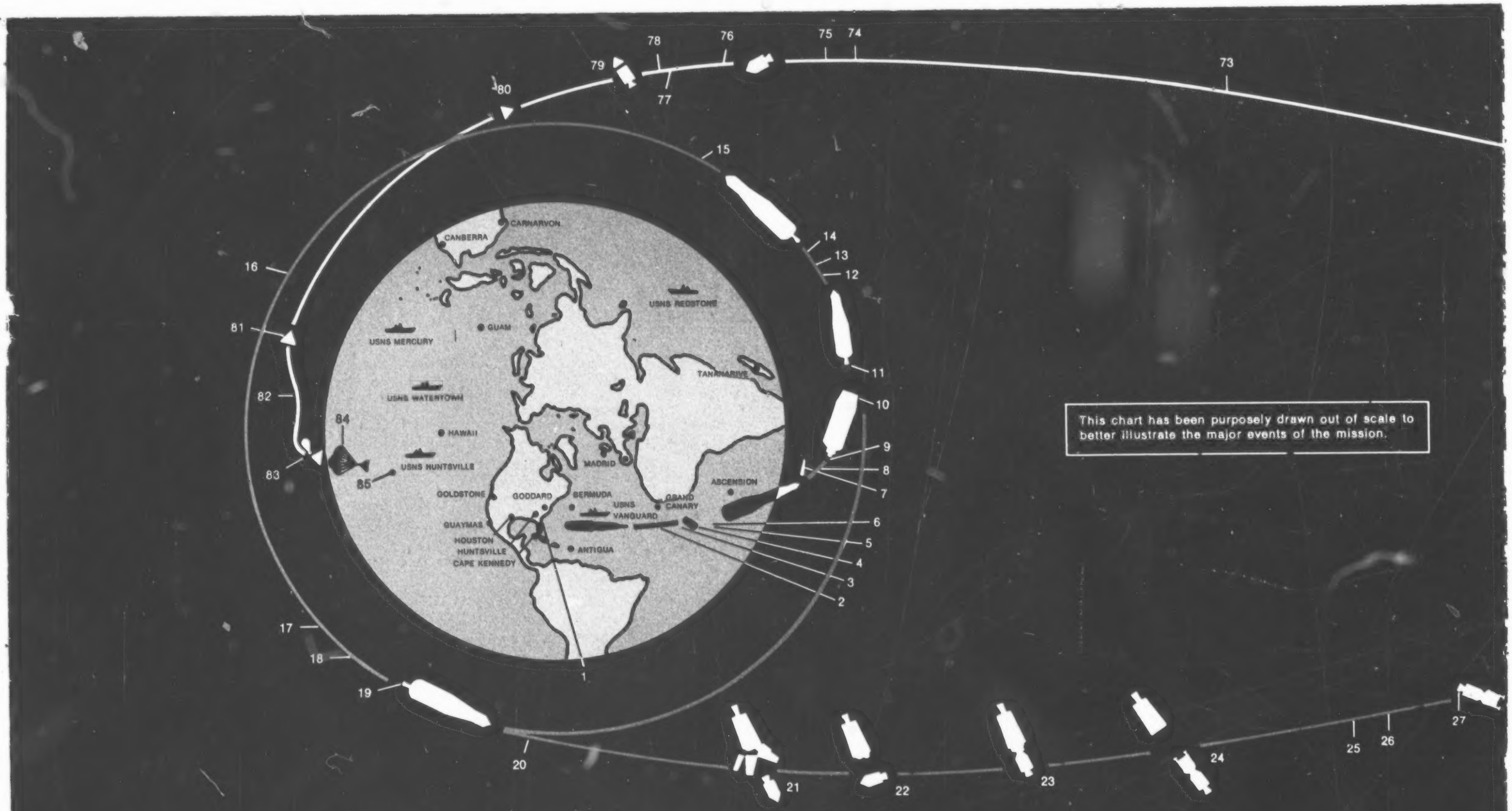


"Men's conception of themselves and of each other has always depended on their notion of the Earth . . . To see the Earth as it truly is, small and blue and beautiful in that eternal silence where it floats, is to see ourselves as riders on the Earth together . . . brothers who know now they are truly brothers."—Archibald MacLeish, during Apollo 8 flight, 1968.



50. Touch Down
51. LM System Checkout
52. Explore Surface, Set Up Experiments
53. LM Prelaunch Checkout
54. Rendezvous Radar Track CSM
55. Liftoff
56. LM Ascent
57. Concentric Sequence Initiation
57A. Plane Change Initiate
58. Constant Delta Height Maneuver
58A. Terminal Phase Initiation
59. Midcourse Correction
60. Rendezvous Maneuvers
61. CSM/LM Initial Docking
62. Transfer Crew and Equipment from LM to CSM
63. CSM/LM Separation and LM Jettison
64. Determine Transearth Injection Thrusting Parameters
65. Transearth Injection
66. Systems Status Check Eat and Sleep Period Data Transmit Period
67. Orient CSM Attitude for Midcourse Correction
68. 1ST Midcourse Correction Transearth
69. System Status Check Eat and Sleep Periods Data Transmit Periods
70. CSM Guidance System Reference Alignment
71. Orient CSM for Midcourse Correction
72. Midcourse Correction if Required
73. System Status Checks Eat and Sleep Periods Data Transmit Periods CSM Guidance System Reference Alignment
75. Orient CSM for Midcourse Correction
76. Final Midcourse Correction
77. CSM Guidance System Reference Alignment
78. Orient CSM for Command Module/Service Module (CM/SM) Separation
79. CM/SM Separation
80. Orient CM for Reentry
81. 400,000 Ft. Altitude Penetration
82. Communication Blackout Period
83. Jettison Forward Heat Shield and Deploy Drogue Chute
84. Deploy Main Chute
85. Splashdown



This chart has been purposely drawn out of scale to better illustrate the major events of the mission.

LUNAR LANDING MISSION PROFILE

1. Lift-Off
2. S-IC Powered Flight
3. S-IC Engine Cutoff
4. S-IC/S-II Separation, S-IC Retro, S-II Ullage
5. S-II Engines Ignition
6. S-IC/S-II Interstage Jettison
7. Launch Escape Tower Jettison
8. S-II Powered Flight
9. S-II Engines Cutoff
10. S-II/S-IVB Separation, S-II Retro, S-IVB Ullage
11. S-IVB Engine Ignition
12. S-IVB Powered Flight
13. S-IVB Engine Cutoff
14. Earth Parking Orbit
15. Begin Systems Status Checks
16. Command Service Module (CSM) Guidance System Reference Alignment
17. Orient for Translunar Injection
18. S-IVB Ullage
19. S-IVB Engine Ignition
20. Translunar Injection
21. CSM Separation from Lunar Module (LM) Adapter
22. CSM 180° Turnabout
23. CSM Docking With LM/S-IVB
24. CSM/LM Separation From S-IVB
25. CSM Guidance System Reference Alignment
26. Orient Space Craft Attitude For Midcourse Correction
27. SM Engine Ignition
28. 1st Midcourse Correction Translunar
29. Systems Status Checks Eat and Sleep Periods Data Transmit Periods
30. CSM Guidance System Reference Alignment
31. Orient Space Craft Attitude for Midcourse Correction
32. Midcourse Correction, If Required
33. System Status Checks Eat and Sleep Period Data Transmit Period
34. CSM Guidance System Reference Alignment
35. Orient S/C Attitude for Midcourse Correction
36. Final Midcourse Correction Translunar
37. CSM Guidance System Reference Alignment
38. Orient Space Craft Attitude for Lunar Orbit Insertion
39. Lunar Orbit Insertion
40. Begin Lunar Orbit
41. CSM Guidance System Reference Alignment

41A. 1ST 2 Lunar Orbits 69 x 195 M.
41B. Circularization Burn Beginning of 3RD Orbit
42. System Status Check
43. Pilot Transfer to LM
44. LM Systems Activation and Checkout
45. CSM/LM Separation
46. Orient LM for Descent Orbit Insertion
47. Descent Orbit Insertion
48. LM Guidance System Reference Alignment
49. LM Descent